# Final Wicomico River Watershed Management Plan - Updated

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Clean Water, Smart Growth

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## Table of Contents

**EXECUTIVE SUMMARY ........................................................................ viii**

**SECTION 1. INTRODUCTION ........................................................................1**

1.1 Process for Developing the Wicomico Watershed Management Plan ....................1
1.2 U.S. EPA Watershed Planning "A-I Criteria" .......................................................2
1.3 Plan Organization ..........................................................................................3
1.4 Caveats ........................................................................................................4

**SECTION 2. WATERSHED CHARACTERIZATION ..............................................5**

2.1 Introduction ..................................................................................................5
2.2 Stream Conditions ..........................................................................................9
2.2.1 Total Maximum Daily Loads ..........................................................................10
2.2.2 Biological Conditions ....................................................................................12
2.2.3 Water Quality Conditions ..............................................................................16
2.2.4 Sources of Impairment ..................................................................................21
2.3 Natural Resources ..........................................................................................23
2.3.1 Ecological Areas ...........................................................................................23
2.3.2 Protected Lands ............................................................................................27
2.4 Classification of Subwatersheds ......................................................................28
2.5 Sea Level Rise ...............................................................................................30

**SECTION 3. WATERSHED ASSESSMENT PROTOCOLS ..................................32**

3.1 Introduction to the Watershed Assessment .......................................................32
3.2 Stormwater Retrofit Inventory .........................................................................32
3.3 Unified Subwatershed and Site Reconnaissance .................................................34
3.3.1 Hotspot Investigations ..................................................................................34
3.3.2 Neighborhood Source Assessment ..................................................................35
3.4 Unified Stream Assessment ............................................................................36
3.5 Identification of Protection Opportunities .......................................................36

**SECTION 4. FINDINGS ..................................................................................39**

4.1 Subwatershed Assessment General Findings ......................................................39
4.1.1 Nomenclature ...............................................................................................39
4.1.2 General Findings ...........................................................................................40
4.1.3 Lakes and Ponds ...........................................................................................44
4.1.4 Tree Planting Opportunities ...........................................................................46
4.2 South Prong Subwatershed Findings ................................................................47
4.2.1 South Prong Overview ...................................................................................47
4.2.2 South Prong Field Assessment and Findings ....................................................49
4.2.3. South Prong Protection Strategy ....................................................................59

4.3 Tony Tank Subwatershed Findings ........ 61
4.3.1 Tony Tank Overview ........ 61
4.3.2 Tony Tank Field Assessments and Findings ........ 63
4.3.3. Tony Tank Protection Strategy ........ 74
4.4 North Prong Subwatershed Findings ........ 76
4.4.1 North Prong Overview ........ 76
4.4.2. North Prong Field Assessments and Findings ........ 78
4.4.3. North Prong Protection Strategy ........ 92

**SECTION 5. ACTION PLAN ........ 94**

5.1. Watershed Restoration Action Strategies ........ 94
5.2 Implementation Planning and Costs ........ 98
5.3 Monitoring Plan ........ 109
5.4 Project Tracking ........ 110
5.5 Long Term Goals ........ 110

**REFERENCES ........ 111**

## List of Figures

Figure 2. 1. Wicomico River Watershed ........ 8

Figure 2. 2. Location and Ranking of Fish Index of Biological Integrity (FIBI) Sites ........ 14

Figure 2. 3. Location and Ranking of Benthic Macroinvertebrate Index of Biological Integrity (IBI) Sites ........ 15

Figure 2. 4. Average Monthly Total Nitrogen Concentration (mg/l) ........ 17

Figure 2. 5. Average Monthly Total Phosphorus Concentration (mg/l) ........ 17

Figure 2. 6. Total Phosphorus Values for Selected Creekwatcher Sampling Sites ........ 19

Figure 2. 7. Total Nitrogen Values for Selected Creekwatcher Sampling Sites ........ 20

Figure 2. 8. E.coli and Total Coliform Concentrations in Salisbury Outfalls ........ 22

Figure 2. 9. Protection and restoration subwatershed priorities as identified by the Core Team ........ 30

Figure 2. 10. Sea level rise inundation scenarios for the Wicomico River watershed ........ 31

Figure 4. 1. Wet pond with weir outlet structure to road ditch ........ 41

Figure 4. 2. Rain garden opportunity at Prince Street School ........ 42

Figure 4. 3. Opportunity for ditch restoration in SP_NSA_6. ........ 43

Figure 4. 4. Better site design and stormwater treatment reduce phosphorus loading (Caraco, 2001)....45

Figure 4. 5. Soil distribution across the South Prong subwatershed....48

Figure 4. 6. (a) Bioretention opportunity at SP_RRI_15A; (b) sediment build-up in Ward Museum parking lot (SP_RRI_305A); and (c) existing wet pond at SP_RRI_17 could be retrofit to provide additional water quality treatment....50

Figure 4. 7. (a) Opportunity for stormwater treatment at SP_NSA_15; (b) Opportunity for tree planting around a stormwater pond at SP_NSA_5; and (c) Opportunity for ditch restoration at SP_NSA_6....54

Figure 4. 8. (a) Commercial vehicle washing on impervious cover (HSI_20a) and (b) improperly stored materials (HSI_20b)....54

Figure 4. 9. (a) RCH 13 - "excellent reach" and (b) channelized section of RCH4 - "poor" reach....57

Figure 4. 10. (a) Impacted buffer (IBI 701) has been overrun with invasive Japanese knotweed and (b) channel modification (CM 3101) at the airport....58

Figure 4. 11. (a) Very poor stream reach with no buffer and hardened banks (SP_RCH_8); (b) Excellent stream reach with floodplain access and good buffer (SP_RCH_33); and (c) Opportunity for buffer enhancement (SP_IB_501)....59

Figure 4. 12. Priority areas for protection in the South Prong subwatershed....60

Figure 4. 13. Soil Distribution across the Tony Tank subwatershed....62

Figure 4. 14. (a) Location for regenerative stormwater conveyance at RRI_41a; (b) wooden box pipe to be removed at RRI_41a; (c) location for bioretention facility to treat parking lot runoff at RRI_41b....64

Figure 4. 15. (a) Opportunity for outreach regarding lawn maintenance at TT_NSA_37; (b) dirty parking lots at TT_NSA_39; and (c) ample opportunity for tree planting at TT_NSA_22....68

Figure 4. 16. (a) Municipal vehicle washing on impervious surface (TT_HSI_67); (b) batteries stored outside without cover or containment (TT_HSI_22b); and (c) poor trash management (TT_HSI_22a)....69

Figure 4. 17. (a) RCH_33 - "excellent reach;" (b) trash in RCH_37 - "poor" reach; and (c) "fair" tidal RCH_26....72

Figure 4. 18. (a) Hotspot operation and impacted buffer (IB46-1); (b) impacted buffer in Canal Woods development (IBI3_1) and (c) opportunity to engage local neighbors in a volunteer trash clean-up (TR36_1)....74

Figure 4. 19. Priority areas for protection in the Tony Tank subwatershed....75

Figure 4.20. Soil distribution across the North Prong subwatershed....80

Figure 4.21. (a) High pollution severity as evidenced by a highly managed lawn at NP_NSA_19a; (b) Stormwater pond at NP_NSA_20 with opportunity for vegetated buffer,

pond retrofit and floating wetlands to improve water quality; and (c) Opportunity for rain gardens at NP_NSA_19b ....................85

Figure 4.22. (a) Highly manicured lawn at NP_NSA_21 with high pollution severity and little available space for restoration; (b) Lots with little tree canopy at NP_NSA_8; and (c) Stormwater pond mowed to edge at NP_NSA_10. ....................85

Figure 4.23. HSI_30 (a) 55-gallon unlabeled drums, rusting and knocked over at Line X and (b) Raw materials and trash strewn about behind the commercial property at the southeast corner of Northwood Drive and Alexander Avenue. ....................88

Figure 4.24. HSI_10 (a) Restaurant grease container at Mr. Pauls, open with stains all around and (b) Chemicals in unlabeled containers outside without cover or containment at Boulevard Motors. ....................89

Figure 4.25. Outdoor vehicle washing at (a) Sherwood of Salisbury (HSI_14) and (b) Pohanka of Salisbury (HSI_15a). ....................89

Figure 4.26. HSI_31 (a) and (b) Poor erosion and sediment control (ESC) practices at Jubilant Cadista ....................89

Figure 4.27. (a) Staining on parking lot leading to storm drain at Hunan Delight (HSI_5) and (b) Raw materials stored outside without cover at the Perdue plant (HSI_12). ....................90

Figure 4. 28. (a) RCH 101a - "excellent reach" with wide, forested buffer and good floodplain connectivity and (b) RCH 104 - "very poor" reach in the headwaters modified as a drainage ditch. ....................93

Figure 4. 29. (a) Headwater stream modified as tax ditch (IB105_2); (b) impervious lot to edge of stream (IB204_1); (c) Trash accumulation at TR113a_1; and (d) Dumping at TR304_1. ....................94

Figure 4.30. Priority areas for protection in the North Prong subwatershed ....................96

## List of Tables

Table 1. 1. U.S. EPA Watershed Planning "A-I" Criteria ....................3

Table 2. 1. Wicomico River Watershed Summary Characteristics ....................7

Table 2. 2. Water Quality Impairment Listing and Status ....................9

Table 2. 3. Subwatersheds and Representative Creekwater Sample Sites ....................16

Table 2. 4. Water Quality Thresholds (mg/l) ........................................................................16
Table 2. 5. Summary of Major and Minor NPDES Individual Permits ..................................23
Table 2. 6. Summary of RTE Plant and Animal Species........................................................24
Table 2. 7. Summary of Percent Ecological Areas in Wicomico River Watershed.................26
Table 2. 8. Summary of Protected Land in Wicomico River Watershed ................................27
Table 2. 9. Subwatershed Classification and Management Strategies ...................................28

Table 3. 1. Potential Hotspot Pollution Sources ....................................................................35
Table 3. 2. Types of Projects Identified during Neighborhood Source Assessment................36
Table 3.3. GIS Layers used to Identify Protection Priorities in the South Prong Subwatershed ..............................................................................................................................367

Table 4. 1. Site Naming Nomenclature .................................................................................39
Table 4. 2. Tree planting opportunities (acres) .....................................................................46
Table 4. 3. South Prong Subwatershed Characteristics.........................................................47
Table 4. 4. Soils in the South Prong Subwatershed...............................................................47
Table 4. 5. General Findings from South Prong Field Assessments.......................................49
Table 4. 6. High Priority Stormwater Retrofit Opportunities in the South Prong ...................51
Table 4. 7. Priority Neighborhood Source Control Opportunities in the South Prong Subwatershed ......................................................................................................................52
Table 4. 8. Priority Hotspot Sites in the South Prong Subwatershed......................................55
Table 4. 9. Stream Reach Scoring Criteria ...........................................................................56
Table 4. 10. Summary of Noted Stream Improvement Opportunities and Impacts.................57
Table 4. 11. High Priority Stream Impacts in the South Prong Subwatershed........................58
Table 4. 12. Tony Tank Subwatershed Characteristics .........................................................61
Table 4. 13. Soils in the Tony Tank Subwatershed................................................................61
Table 4. 14. General Findings from Tony Tank Field Assessments .......................................63
Table 4. 15. Priority Stormwater Retrofit Opportunities in the Tony Tank subwatershed ......65
Table 4. 16. Neighborhood Source Control Opportunities in Tony Tank ...............................67
Table 4. 17. Priority Hotspot Sites in the Tony Tank Subwatershed ......................................70
Table 4. 18. Stream Reach Scoring Criteria .........................................................................71
Table 4. 19. Summary of Noted Stream Improvement Opportunities and Impacts.................72
Table 4. 20. Priority Stream Opportunities in the Tony Tank Subwatershed..........................73

Table 4.21. North Prong Subwatershed Characteristics ......................................................738
Table 4.22. Soils in the North Prong Subwatershed............................................................739
Table 4.23 General Findings from North Prong Field Assessments .......................................81
Table 4.24. Priority Stormwater Retrofit Opportunities in the North Prong ...........................83
Table 4.25 Modifications to Existing Stormwater Management Facilities .............................84
Table 4.26. Neighborhood Source Control Opportunities in the North Prong Subwatershed..86
Table 4.27 Priority Hotspot Sites in the North Prong Subwatershed ......................................91
Table 4.28. Stream Reach Scoring Criteria a .........................................................................92
Table 4.29. Stream Impacts in the North Prong Subwatershed ..............................................93
Table 4.30 Summary of Noted Stream Improvement Opportunities and Impacts...................95

Table 5. 1. South Prong Implementation Strategy .................................................................99
Table 5. 2. Implementation Actions and Costs .....................................................................104
Table 5. 3. Wicomico Watershed Restoration Implementation Parties.................................107

APPENDIX
A. Watershed Characterization Report (Section 2.0) Appendices
A-A. Indices of Biological Integrity for the Wicomico Watershed
A-B. Point Sources in the Wicomico Watershed
A-C. Protection and Restoration Subwatershed Metric and Scoring Rules
A-D. Subwatershed Restoration and Protection Final Scores
APPENDIX B. South Prong Subwatershed Site Location Maps
APPENDIX C. Tony Tank Subwatershed Site Location Maps
APPENDIX D. North Prong Subwatershed Site Location Maps
APPENDIX E. Summary of Projects in the South Prong Subwatershed
APPENDIX F. Summary of Projects in the Tony Tank Subwatershed
APPENDIX G. Summary of Projects in the North Prong Subwatershed
APPENDIX H. Ranking Metrics
APPENDIX I. Maryland Assessment Scenario Tool Scenarios
APPENDIX J. Best Management Practice Profile Sheets
APPENDIX K. South Prong Subwatershed Field Forms
APPENDIX L. Tony Tank Subwatershed Field Forms
APPENDIX M. North Prong Subwatershed Field Forms

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# EXECUTIVE SUMMARY

## E.1 About This Update

The first iteration of the Wicomico River Watershed Management Plan was completed in March, 2013 and included a baseline assessment, comparative subwatershed assessment and action plans for two subwatersheds, the South Prong and Tony Tank Subwatersheds. Additional funding was obtained by the Wicomico Environmental Trust to complete an action plan for a third subwatershed, the North Prong of the Wicomico. This updated plan includes findings from North Prong field assessment and integrates those findings into the overall Watershed Management Plan. Integration of the North Prong findings into this plan completes watershed planning efforts for the three subwatersheds identified overall for "restoration" practices. The remaining four subwatersheds – Monie Bay, Wicomico Creek, Shiles Creek and Ellis Bay – were identified for overall "protection" efforts. As of this writing, a grant is pending to the National Fish and Wildlife Foundation to complete field assessments for those four subwatersheds.

Since completion of the original Watershed Plan, a significant amount of momentum has occurred related to restoration of the Wicomico River, including actual implementation of projects. These successes include:

- Design and construction of a bioretention and living shoreline project in downtown Salisbury;
- Design and construction of 9 projects in the Wicomico watershed, including:
    - Submerged gravel wetland at the airport (South Prong);
    - Dry pond retrofit and bioretention at the County detention center (North Prong);
    - Rain garden at the Upper Ferry crossing (Shiles Creek);
    - Regenerative stormwater conveyance and bioretention at Pemberton Park (Tony Tank);
    - Rain garden and bioretention at the County Roads Division (Tony Tank);
    - Regenerative stormwater conveyance and bioretention at Schumaker Park (South Prong);
    - Bioretention and pond retrofit at the Perdue Stadium (South Prong);
    - Three bioretentions at East Wicomico Little League Complex (South Prong); and
    - Wetland creation at Wor-Wic Community College (South Prong).

## E.2. Introduction

Located on the Eastern Shore of Maryland, the Wicomico River Watershed is approximately 230 square miles in size, encompassing portions of Wicomico County, Somerset County, Worcester County, City of Salisbury, City of Fruitland and Sussex County, Delaware. The stream network includes the Wicomico River main stem and seven subwatersheds as delineated by the United State Geological Survey: the North Prong, South Prong (referred to locally as the East Prong), Tony Tank, Shiles Creek, Wicomico Creek, Ellis Bay and Monie Bay. The watershed is dominated by a mix of agricultural, wetland, forest, and developed land covers. The Wicomico River has 13 local Total Maximum Daily Load (TMDL) impairments on various parts of the river. Most of the impairments are for nutrients (nitrogen and phosphorus), sediment and fecal coliform (see Section 2.2.1). The Wicomico River also falls under the Chesapeake Bay TMDL that allocates nutrient and sediment reductions for each Bay state. For Maryland, this equates to a 25% reduction in nitrogen, 24% reduction in phosphorus and 20% reduction in sediment. These reductions were further broken down by county and major river basin. At the state level, Phase I and Phase II Watershed Implementation Plans (WIPs) were developed to determine how each state will help meet pollutant reductions.

According to the Maryland Department of Environment (MDE) TMDL reports, the probable sources of fecal coliform in the watershed are wildlife, human, livestock and pets (MDE, 2008). Other potential sources include manure spreading, direct deposition from livestock, failing septic systems and leaking sanitary infrastructure. Sources of nutrients include non-point sources and agricultural land, particularly for phosphorus. Point sources for nutrients have also been identified and these include the wastewater treatment plants (Salisbury, Fruitland and Delmar) and Perdue Farms, Inc.

In June, 2012, October, 2012, and November, 2013 extensive retrofit, upland and stream field assessments were conducted throughout three Wicomico subwatersheds – the South Prong, Tony Tank, and North Prong - to evaluate pollution management and watershed restoration opportunities. During these assessments, field crew teams visited over 507 locations in the watershed and used one of four field assessment methodologies to evaluate the feasibility of implementing a management or restoration practice. Approximately 151 potential stormwater retrofit sites, 73 potential hotspot locations, 82 residential neighborhoods and 21.2 miles of stream (63 stream reaches) were assessed. Common problems observed in the watershed included a lack of stormwater management at older development sites, inadequate stormwater treatment at some sites, improper outdoor material storage and waste management, inadequate riparian buffer areas, trash, and impoundments throughout. Many opportunities for restoration projects and programs were identified.

One key component of the *Wicomico River Watershed Management Plan (Plan)* was to develop specific watershed protection and restoration objectives and then rank and prioritize the proposed projects identified from the field work according to these watershed objectives. A list of ranked watershed management and restoration projects along with estimated project costs are listed in Appendices E-G of this *Plan.* Some higher priority projects are discussed in detail by subwatershed in Section 4, and are mapped in Appendices B -D. Watershed projects were ranking according to the following watershed factors:

- *Cost* – The cost associated with project implementation. Project costs represent only planning level estimates and were determined based on guidance provided in Schueler et al. (2007), Wright et al. (2005) and Kitchell and Schueler (2004).
- *Community Education and Involvement* – Project with potential to educate and involve the community.
- *Visibility* – Project with high visibility and potential to raise the public's awareness of the watershed (e.g. visible from street or located in public park).
- *Feasibility* – Project with high potential that it will be implemented. The site has access for equipment, low maintenance burden, serves as a demonstration site and is publicly owned.
- *Water Quality Improvement* – Potential for treatment or prevention of pollutants. Treats water quality volume or eliminates exposure of pollutants to stormwater runoff.
- *Ecological Benefit* – Project provides an ecological, habitat, or natural resource protection benefit.
- *Protection Priority* – Project is located within a high priority or priority protection area as shown by maps in Section 4.1.5.
- *Meeting Watershed Goals* – Potential for project to assist in meeting watershed goals (see section below).

## E.3 Watershed Goals, Objectives and Strategies

To guide the development of this plan, a watershed vision, goals and objectives were established by the Core Team, which consists of the City, County, and State representative, local non-governmental organizations and other interested parties, and three public stakeholder meetings. The watershed vision, goals and objectives are stated below.

**Wicomico Watershed Vision**

*The citizens of the Wicomico River Watershed want to reduce pollution entering the Wicomico River and the Chesapeake Bay through partnerships and cooperative efforts to restore and protect watershed lands. We envision a river healthy enough to sustain robust fish and shellfish populations, human recreational activities, and surrounding wildlife. We believe that a healthy river reflects our rural, small town values and protects our natural landscape.*

**Goal 1. Improve water quality.**

Objective 1 – Contribute to County nutrient and sediment reductions for the Chesapeake Bay Total Maximum Daily Load (TMDL) and local TMDLs for the River.

Objective 2 – Decrease stream erosion and sedimentation.

Objective 3 – Promote behavior change for local residents and property owners to change practices through education and demonstration projects.

Objective 4 – Determine most effective water quality improvement actions for each lake/pond in the watershed.

Objective 5 – Encourage enforcement of existing laws and policies that includes best management practice (BMP) inspection and oversight of construction sites.
Objective 6 – Reduce the impact of impervious surfaces.

**Goal 2. Protect existing resources.**

Objective 1 – Protect green infrastructure and ecologically significant areas.
Objective 2 – Protect farmland.
Objective 3 – Protect existing wetlands and natural areas.
Objective 4 – Protect the community's drinking water supplies and aquifers.

**Goal 3. Restore watershed function.**

Objective 1 – Restore green infrastructure, in-stream and upland habitat, and shellfish beds.
Objective 2 – Reduce localized flooding.
Objective 3 – Plan for the impacts of sea level rise.
Objective 4 – Promote residential homeowner practices (i.e. rain gardens, rain barrels), including the reduction in the application of fertilizer, esp. during certain times of the year.
Objective 5 – Promote the use of Agricultural BMPs.

**Goal 4. Educate the Public on Watershed Restoration Efforts.**

Objective 1 – Integrate public education with project implementation where possible.
Objective 2 – Involve the youth in restoration activities.
Objective 3 – Promote recreational opportunities in the watershed.

Based on these watershed objectives and the results of the watershed characterization assessment and field findings, eleven key strategies were developed that are presented in order of implementation priority. These strategies focus on a range of activities from municipal practices and programs, natural resources protection, the treatment of polluted runoff, and source control and education.

1. **Transition the Core Team into a long term management structure.**
2. **Prevent further degradation in the subwatersheds by implementing protection efforts.**
3. **Implement pollution prevention measures at municipal and private sites, including employee training.**
4. **Encourage pollution prevention practices as well as tree planting and landscape management in residential neighborhoods.**
5. **Plant trees watershed-wide to increase tree canopy.**
6. **Implement high priority stormwater retrofit practices, particularly educational/demonstration projects.**
7. **Implement priority stream improvement projects.**
8. **Investigate strategies for pond management.**
9. **Minimize the creation of impervious surfaces during the development review process.**

10. **Educate homeowners regarding advanced nutrient removal septic systems and connect failing septic systems to the sewer system as per the County's Water and Sewerage Plan (2010).**
11. **Track and monitor the implementation progress.**

These strategies are detailed in Section 5 of this *Plan.* Section 5 also details recommended short-term, mid-term, and long-term actions to support these strategies.

## E.4 Implementation Costs and Timeline

Implementation is by far the longest and most expensive step in the watershed management process. In fact, restoration and protection costs for a single suburban subwatershed can easily range in the million dollars depending on the extent of restoration and protection activities, number of jurisdictions involved, land costs, and other factors. Section 5 of this Plan presents information on planning partners, planning level costs, and phasing and resources for implementing watershed strategies. Table E.1 below provides a draft implementation schedule and associated costs for implementing each short term, mid-term and long term action. Additional tables in Section 5 provide information on the watershed objectives met through implementation of these strategies, responsible parties, and long-term milestones for implementation of each strategy. Project costs and cost ranges associated with the over 170 identified individual watershed projects and 82 neighborhoods can be found in Appendices E-G. Some individual projects from these lists are incorporated into the implementation plan as examples. *Project partners should consult the appendices to begin implementation of high priority projects and factor costs from the most feasible projects into the overall implementation strategy.*

The cumulative estimate for implementing the 11 strategies is approximately $2.2 million dollars over the short and mid-term (Table E.1). The largest component of these cost results from the estimated cost of acquiring conservation easements (Strategy 2) and implementing stormwater retrofit and stream projects (Strategy 6 & 7). Additional high-dollar costs are associated with hiring a watershed coordinator and implementing pollution prevention measures and municipal and private sites. Costs associated with watershed strategy 2 alone are estimated at over $1.1 million for the mid-term, which assume costs for conservation easements on 467 acres of land and will require the County to become re-certified with the state for the preservation of agricultural land.

## E.5 Pollutant load reductions

Pollution load reductions were estimated for stormwater retrofit projects based on assumptions detailed in Schueler et al. (2007), Hirschman, et al. (2008), and Schueler and Lane (2012). Using these assumptions, the identified projects have the potential to reduce nitrogen by 1,615 lb/yr, phosphorus by 242 lb/yr and total suspended sediment by 72,723 lb/yr. These projects, along with tree planting projects, were input into the Maryland Assessment Tool (MAST), a web-based load estimator tool that builds scenarios for pollutant load reduction based on user-input best management practices (BMPs). The MAST tool is promoted for use to Maryland jurisdictions to assess progress for meeting Chesapeake Bay

TMDL reduction targets. The MAST scenarios for the identified *Plan* projects are presented in Appendix I and indicate a percent change in reduction for each land use sector (municipal Phase II MS4 impervious, municipal Phase II MS4 pervious, nonregulated impervious developed and nonregulated pervious developed) from between 0.1-2.26% for nitrogen, 0.015-11.3% for phosphorus and 0.25-100% for total suspended solids. It should be noted that load reduction targets are expected to change and new BMPs are currently being evaluated for inclusion as creditable practices (e.g. illicit discharge elimination, stream restoration, urban nutrient management). These additional BMPs may provide many more cost effective options for local jurisdiction and communities to meet Chesapeake Bay TMDL load reduction targets. In addition, there may be future opportunity to "trade" reductions across sectors so, for example, when >100% of the reduction could be achieved as in the Municipal Phase II Pervious Load for sediment, the addition reduction could be applied to the Nonregulated Impervious Developed sector.

The MAST tool is not necessarily effective for assessing different management scenarios or programmatic elements and, as such, project partners may want to consider an alternative pollution model. The Watershed Treatment Model (WTM; Caraco, 2002) is able to account for restoration action not considered by MAST (e.g. pet waste education, lawn care education, catch basin cleanouts) and the user can more effectively weigh the costs and benefits of each action as well as compare them to each other. In addition, the WTM accounts for bacteria, a known impairment in the Wicomico watershed, and can also account for future growth and land use change.

**Table E.1. Implementation Actions and Costs***

| Strategy | Short-Term Action (year 1) | Mid-Term Action (year 2-4)[1] | Long-Term Action (year 5+)[2] |
|---|---|---|---|
| 1. Transition the Core Team into a long term management structure | Assign responsible parties for each restoration strategy using this table as well as the projects identified in the Appendices. (20 hrs) | Find funding for support of Watershed Coordinator staff position (80 hrs =$2,400). | Develop long-term work plan for Watershed Coordinator |
| | Determine most logical entity to host a Watershed Coordinator staff position (20 hrs ) | Hire Watershed Coordinator ($35,000/yr/3 yrs) | Ensure that Coordinator actions are effectively directed to meet water quality and watershed restoration goals, which may change over time |
| | Determine specific roles and responsibilities for Watershed Coordinator (20 hrs ) | | Annual salary for Watershed coordinator |
| Strategy 1 Costs | $3,300 | $109,400 | $$$ |
| 2. Prevent further degradation in the subwatershed by implementing protection efforts | Consider passing a 100 foot stream buffer regulation for perennial, intermittent and ephemeral streams (200 hrs) | Adjust restoration and protection planning efforts to account for wetland and buffer migration (100 hrs). | Conduct outreach to landowners of high priority protection areas |
| | Promote the County's Rural Legacy program through outreach and education to landowners, which can support conservation easements on forested and agricultural parcels (100 hrs) | Conduct outreach to landowners of high priority protection areas (200hr/yr/3 yrs) | Protect 50% of remaining high priority protection areas (2,101 total acres) and 10% of priority protection areas (981 total acres)[3]. |
| | Promote sustainable management of forests through outreach and education to landowners (100 hrs) | Protect 10% of high priority protection areas (467 total acres)[3] | |
| | County to become re-certified with the MALPH program (40 hours) | | |
| Strategy 2 Costs | $24,200 | $1,109,834 | $$$$ |

**Table E.1. Implementation Actions and Costs***

| Strategy | Short-Term Action (year 1) | Mid-Term Action (year 2-4)[1] | Long-Term Action (year 5+)[2] |
|---|---|---|---|
| 3. Implement pollution prevention measures at municipal and private sites, including employee training. | Conduct a full hotspot assessment of all municipal facilities (5 days for field work, 3 days to post process) | Provide education on pollution prevention to targeted businesses and implement stormwater retrofits and pollution source control measures (4 trainings/yr at 32 hrs/training/3 yrs) | Develop a *Business Stewardship Outreach Program* that engages the business community in watershed restoration |
| | Provide internal employee training to municipal employees regarding pollution prevention and good housekeeping practices (4 trainings/yr at 32 hrs/training) | Continue to provide employee training to municipal employees regarding pollution prevention and good housekeeping practices (2 trainings/yr at 15 hrs/training/3 yrs) | Implement BMPs on private facilities (TT_RRI_31, TT_RRI100c, SP_RRI_101, NP_RRI_17a-c) |
| | Ensure that an enforceable stormwater ordinance for preventing illicit discharges to the storm drain system is in place (320 hrs) | Implement 3 innovative BMPs on municipal properties as demonstration of good stewardship to the community (TT_RRI_55, SP_RRI_1 & NP_RRI19a) | |
| Strategy 3 Costs | $28,160 | $308,070 | $$ |
| 4. Encourage pollution prevention practices as well as tree planting and landscape management in residential neighborhoods | Identify neighborhood leaders for community stewardship (12 hrs) | Expand the storm drain marking program into older neighborhood (6 trainings at 32 hrs/3 yrs) | Increase neighborhood tree canopy and encourage natural buffer regeneration at residences along stream corridors |
| | Develop educational materials for pollution prevention and source control (40 hrs) | Disconnect residential downspouts to allow for treatment and volume reduction of rooftop runoff (100 downspouts @ $50/downspout) | |
| | Encourage tree planting and landscape management in residential neighborhoods (40 hrs + 100 trees at $19/tree) | Develop a targeted residential education program to encompass the proper application of fertilizer and use of alternatives to grass lawns, trash education and promotion of recycling, stream buffer education and conservation landscaping (3/4 FTE staff person) | |

**Table E.1. Implementation Actions and Costs***

| Strategy | Short-Term Action (year 1) | Mid-Term Action (year 2-4)[1] | Long-Term Action (year 5+)[2] |
|---|---|---|---|
| | | Assess ditch restoration opportunities in neighborhoods as strategy to meet water quality goals (100 hrs) | |
| Strategy 4 Costs | $6,960 | $63,680 | $$ |
| 5. Plant trees watershed-wide to increase tree canopy | Determine responsible entities for implementing and maintaining tree planting projects (20 hours) | Establish a means of supporting community groups and schools to implement their own tree planting projects, including guidance on maintenance (60 hrs) | Assess status of meeting urban tree planting goals and revise implementation as needed |
| | Align tree planting projects identified in plan with urban tree canopy goals (20 hours) | | |
| | Install some tree planting demonstration projects in highly visible areas (40 hrs each + 100 trees total) | Plant 10% of identified tree planting projects (32 acres @ 100 trees/acre @ $19/tree) | Plant 60% of remaining tree planting projects |
| Strategy 5 Costs | $6,300 | $64,100 | $$$ |
| 6. Implement high priority stormwater retrofit practices, particularly educational / demonstration stormwater retrofit practices | Identify funding sources for retrofits (80 hrs) | Install educational/demonstration stormwater retrofit projects at schools and parks (SP_RRI_15a, SP_RRI_15b, TT_RRI_48, NP_RRI7, NP_RRI23) | Expand the green school program to include additional institutions |
| | Modify, repair, and/or maintain existing stormwater management facilities to improve water quality performance[4] | Develop a green school program that includes reforestation, stormwater retrofits and pollution prevention (300 hrs) | Implement additional high priority stormwater retrofits (TT_RRI_41a, TT_RRI_41b, TT_RRI_74, SP_RRI_102b, SP_RRI_11, NP_RRI34a-b, NP_ RRI 8, NP_RRI10a) |
| | Engage the public through implementation of highly visible, low cost demonstration projects (SP_RRI_8b, SP_RRI_24, NP_RRI1) | Implement stormwater management into existing municipal parking lots during redevelopment (code changes: 200 hrs) | Continue to identify retrofit opportunities at schools, neighborhoods, commercial areas, and outfalls that do not have existing BMPs |
| | Engage neighborhood residents in buffer planting project (TT_IB36_1) | Further assess opportunities in neighborhoods with little or no existing stormwater management (72 hrs) | |
| Strategy 6 Costs | $27,400 | $101,960 | $$$ |

**Table E.1. Implementation Actions and Costs***

| Strategy | Short-Term Action (year 1) | Mid-Term Action (year 2-4)[1] | Long-Term Action (year 5+)[2] |
|---|---|---|---|
| 7. Implement priority stream improvement projects | Conduct quarterly stream clean-ups (4 events/yr) | Implement additional high-priority stream projects, such as buffer restoration (SP_IB2101, TT_IB36_1, NPIB_105_1). | Incorporate new stream, data into GIS layers and use the data during development plan reviews |
| | Continue use of bag filters on outfalls and consider expansion of program ($20,000/net@5 nets + $5,000 maintenance costs)[5] | Update watershed mapping to account for and differentiate between perennial and intermittent streams. (40 hrs) | Continue to implement additional high-priority stream projects (SP_IB2601; TT_IB5_1; SP_IB_301; NPIB105_2; NPIB104_1). |
| | Continue implementation of illicit discharge outfall screening program ($25,000/year)[6] | Determine potential for Coast Guard auxiliary to assist with trash clean-ups or citizen monitoring efforts in the lower watershed that can only be accessed by boat. (40 hrs) | Implement large demonstration project at SP_SC301 |
| | Obtain grant funding to conduct feasibility study of large-scale water quality improvement project at SP_SC_301 (25 hrs) | Hold regular living shoreline and conservation landscape workshops. (4 events at 32 hrs/3yrs) | |
| | Educate the citizenry regarding invasive species like Japanese knotweed and their control (4 events at 15 hrs each=$1,800) | Implement 1-2 fish barrier projects (TT_SC26_1) | |
| | Control invasive species like Japanese knotweed, esp. in the headwaters (SP_IB1701) | Implement feasibility study at SP_SC_301 ($35,000) | |
| | Conduct outreach to landowners on the river for living shoreline projects (4 events at 32 hrs each) | | |
| Strategy 7 Costs | $149,315 | $74,420 | $$ |

| Table E.1. Implementation Actions and Costs* | | | |
|---|---|---|---|
| **Strategy** | **Short-Term Action (year 1)** | **Mid-Term Action (year 2-4)[1]** | **Long-Term Action (year 5+)[2]** |
| 8. Investigate strategies for pond management | Provide educational workshops to lakeside homeowners regarding neighborhood source control practices, septic system maintenance (strategy 9) and benefits of shoreline buffers. (4 events at 32 hrs each)<br>Foster opportunities for residents to interact with lake systems where pollution problems are less of a concern. (4 events at 32 hrs each) | Comprehensive assessment of lakes in the watershed for future action based on pollution, aquatic weeds, flooding and other concerns (1200 hrs) | Implement actions identified in lake restoration assessments. (unknown cost) |
| Strategy 8 Costs | $14,080 | $66,000 | $$$$ |
| 9. Minimize the creation of impervious surfaces during the development review process. | Review the City and County development codes using the Codes and Ordinances Worksheet (COW) (60 hrs) | Implemented needed code revisions as determined by the COW (400 hrs) | Where possible, remove excess or unused impervious cover (SP_RRI_22; SP_RRI_100a; TT_RRI_48; TT_RRI_54b). |
| Strategy 9 Costs | $3,300 | $22,000 | $$ |
| 10. Educate homeowners regarding advanced nutrient removal septic systems and connect failing septic systems to the sewer system as per the County's Water and Sewerage Plan (2010). | Provide educational workshops on septic system maintenance (strategy 7) (4 events at 32 hrs each) | Provide educational workshops on septic system maintenance (strategy 7) (14 events at 32 hrs each) | Extend sanitary infrastructure to high priority lakes with adjacent septic systems. |
| Strategy 10 Costs | $7,040 | $24,640 | $$$$ |
| 11. Track and monitor the implementation progress | Determine capacity limitations of local partners identified in Table 5.3 for implementation and identify ways to build capacity in needed areas (e.g. specific training) (40 hrs)<br>Expand a Creekwatcher monitoring program by adding | Revisit watershed plan and assess status (40 hrs)<br>Provide continuing education regarding project maintenance to homeowners, | Revise this plan as needed to reflect changes in watershed conditions and new priorities. |

| Table E.1. Implementation Actions and Costs* | | | |
|---|---|---|---|
| **Strategy** | **Short-Term Action (year 1)** | **Mid-Term Action (year 2-4)[1]** | **Long-Term Action (year 5+)[2]** |
| | Total suspended solids as parameter (450 samples @ $15/sample = $6,750); conduct detailed synoptic survey of Tony Tank, South Prong, and North Prong ($2500); establish new station in Monie Bay and use as a reference site (40 hrs) | HOAs, schools, municipalities, etc. (4 trainings at 32 hrs each/3 yrs) | |
| | Develop project tracking database in GIS and spreadsheets (40 hrs) | | |
| Strategy 11 Costs | $15,850 | $23,320 | $ |
| **Sub Totals** | **$285,905** | **$1,967,424** | **$$$$** |
| **Grand Total (Short & Mid Term Only)** | **$2,253,329** | | |
| *Note: These cost estimates include staff time, materials, supplies, and construction costs where applicable. A $55 hourly rate was assumed in all calculations. Best professional judgment was used for staff time estimates, projects costs are from Appendix H. Other cost assumptions are documented with footnotes. | | | |
| [1]Costs are calculated for three years within this category where noted, otherwise for one year. A range of 50-150% of estimated costs is provided to account for uncertainty. | | | |
| [2]Costs are calculated for 10 years within this category where noted, otherwise for one year. Since these costs are so unpredictable for the long-term, and likely to change based on inflation and other unknown factors, best professional judgment was used to assign a relative value as such: "$"=$1,000-$10,000; "$$"=$10,000-$100,000; "$$$"=$100,000-$500,000; and "$$$$"=>$500,000. | | | |
| [3]Protection costs based on $2,200/acre, 3% administrative fee to sponsor the project and 1.5% compliance fee. | | | |
| [4]Funding a stormwater post-construction program depends on many factors. See "Managing Stormwater in Your Community: A Guide for Building an Effective Post-Construction Program" (CWP, 2008) for more information and guidance on developing a budget. | | | |
| [5]Costs from CWP Gross Solids project in Talbot County. | | | |
| [6] Brown el al (2004). | | | |

Long-term goals have been set in the implementation strategy to mark progress to ensure the implementation of the *Plan* adheres to a schedule to meet the defined outcomes.

- Meet interim milestones from Table E.1 for each strategy
- Reduce baseflow concentrations of nitrogen, phosphorus and bacteria at Creekwatcher monitoring stations to meet local and Chesapeake Bay TMDL reductions. Implementation plans are needed to address bacteria impairments; this is currently not addressed in local TMDLs.
- Evaluate at five years any improvements in trends that may have occurred due to implementation efforts.

After 5 years time, this *Plan* should be updated to include recent watershed developments and monitoring results.

# SECTION 1. INTRODUCTION

## *1.1 Process for Developing the Wicomico Watershed Management Plan*

The *Wicomico River Watershed Management Plan (the Plan)* is the culmination of over two years of extensive desktop analyses, field assessments, and stakeholder meetings conducted by the Center for Watershed Protection (the Center) and project partners. The work was completed under two different contracts, one with the City of Salisbury (the City) under a National Fish & Wildlife Foundation grant and one with the Wicomico Environmental Trust (WET) under a Chesapeake Bay Trust grant. The tasks identified within the scope of work with the City included:

1. Develop a Watershed Characterization Report for the Wicomico River Watershed
2. Holding one stakeholder meeting;
3. Identify potential restoration and protection opportunities by conducting riparian corridor, upland pollution prevention, and stormwater retrofit assessments; and
4. Craft a Wicomico Watershed Plan and one Subwatershed Action Plan for a prioritized subwatershed, which was determined to be the South Prong.

The tasks identified within the scope of work with WET included:

1. Identify potential restoration and protection opportunities in the Tony Tank subwatershed by conducting riparian corridor, upland pollution prevention, and stormwater retrofit assessments;
2. Estimate pollutant load reductions for the identified projects; and
3. Craft a Subwatershed Action Plan for the Tony Tank.

Although not included in either scope of work, one additional public stakeholder meeting was held as it was determined that engaging the public was deemed an integral part of the overall success of the project. Identified projects and their locations are listed in separate appendices for the South Prong, Tony Tank and North Prong subwatersheds (Appendices B -D contain location maps for each of the subwatersheds and Appendices E-G contain project tables for each of the subwatersheds. Because watershed restoration action strategies contain broader recommendations that are applicable to both subwatersheds, these were combined in one overall Action Plan detailed in Section 5. For prioritized project lists identified within each subwatershed, see the appropriate appendices.

The initial task in developing this *Plan* was to develop an understanding of the baseline, or current, conditions of the Wicomico River watershed. To accomplish this, the Center first reviewed existing watershed data, studies, and reports. In addition, the Center analyzed watershed Geographical Information System (GIS) data. As part of the baseline assessment, the Center conducted a Comparative Subwatershed Assessment to broadly characterize each subwatershed, its restoration potential and associated restoration strategies as well as to prioritize one subwatershed in which to conduct field assessments.

The next major task in developing this *Plan* was to identify stormwater retrofit, pollution prevention, and stream restoration opportunities in the watershed. The Center conducted upland and stream field assessments in the South Prong subwatershed in June, 2012. During this assessment period, field crews assessed approximately 46 potential retrofit sites, 25 potential hotspot locations, 23 residential neighborhoods, and 8.4 miles of stream (22 stream reaches). The Center conducted upland and stream field assessments in the Tony Tank subwatershed in October, 2012. During this assessment period, field crews assessed approximately 54 potential retrofit sites, 19 potential hotspot locations, 24 residential neighborhoods, and 5.0 miles of stream (22 stream reaches). The Center conducted upland and stream field assessments in the North Prong subwatershed in November, 2013. During this assessment period, field crews assessed approximately 51 potential retrofit sites, 29 potential hotspot locations, 35 residential neighborhoods, and 7.8 miles of stream (19 stream reaches). The findings of the fieldwork are summarized in Section 4 of this *Plan*.

Using input from the Core Team, the Center developed a ranking system to prioritize identified management and restoration practice opportunities. Using best professional judgment, each project was assigned points and ranked according to several factors including: cost; community education and involvement, visibility; feasibility; water quality improvement; ecological benefit; protection priority; and the ability to meet the watershed objectives.

The Center, using input from the Core Team, developed watershed management objectives. The Center then re-examined all data collected over the course of the project – baseline information, field observations, field assessment results, Wicomico River Watershed goals and objectives – and developed 11 key management and protection strategies for the watershed, as described in Section 5. These 11 strategies are the core of this *Plan.* They provide a framework for implementing the numerous management and restoration practices identified through field assessments as well as program and education related recommendations.

Recommended short-term, mid-term, and long-term actions to support the 11 watershed strategies are presented in Section 5. A detailed implementation plan was compiled that outlines the key watershed actions and information on individuals responsible for implementation, an implementation timeline, and summary cost information. Information on project tracking and monitoring are also provided.

### *1.2 U.S. EPA Watershed Planning "A-I Criteria"*

In 2003, the U.S. Environmental Protection Agency (EPA) began to require that all watershed restoration projects funded under Section 319 of the federal Clean Water Act to be supported by a watershed plan that includes the following nine minimum elements, known as the "a-i criteria":

a. Identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the watershed plan
b. Estimates of pollutant load reductions expected through implementation of proposed nonpoint source (NPS) management measures
c. A description of the NPS management measures that will need to be implemented
d. An estimate of the amount of technical and financial assistance needed to implement the

plan

e. An information/education component that will be used to enhance public understanding and encourage participation
f. A schedule for implementing the NPS management measures
g. A description of interim, measurable milestones
h. A set of criteria to determine load reductions and track substantial progress towards attaining water quality standards
i. A monitoring component to determine whether the watershed plan is being implemented

This *Plan* meets the a-i criteria. Table 1. 1 shows where these criteria are addressed throughout this document.

**Table 1. 1. U.S. EPA Watershed Planning "A-I" Criteria**

| Section of the report | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| Section 1. Introduction | | | | | | | | | |
| Section 2. Watershed Characterization | X | | | | | | | | |
| Section 3. Watershed Assessment Protocols | | | | | | | | | |
| Section 4. Watershed Assessment Findings | | X | X | | | | | | |
| Section 5. Action Strategies | | | X | X | X | X | X | X | X |
| Appendix A. Watershed Characterization Report Appendices | X | | | | | | | | |
| Appendices B -D. Site Location Maps | | | X | | | | | | |
| Appendix E-G. Summary of Projects in the South Prong, Tony Tank and North Prong Subwatersheds | | X | X | X | | | | | |
| Appendix H. Ranking Metrics | | | | | | | | | |
| Appendix I. Maryland Assessment Scenario Tool Scenarios | | | | | | | | | X |
| Appendix J. Best Management Practice Profile Sheets | | | | | X | | | | |
| Appendices K-M. Field Forms | | | | | | | | | |

*1.3 Plan Organization*

The *Plan* is organized as follows:

Section 1. Introduction – provides an introduction to the Wicomico River Watershed Management Plan.

Section 2. Watershed Characterization of the Wicomico River Watershed – describes the baseline, or current, conditions of natural features, community features, and land use and cover in the Wicomico watershed.

Section 3. Watershed Assessment Protocols – provides an overview of retrofit, stream and upland assessment methodologies.

Section 4. Findings – provides key findings from the subwatershed field assessments.

Section 5. Action Plan – presents the 11 key watershed management strategies based on watershed assessments and desktop analyses conducted by the Center; describes actions that support the key strategies, along with information on planning partners, project phasing, planning level costs, and resources for implementing watershed strategies.

### *1.4 Caveats*

It is important to keep in mind that this *Plan* is limited in scope and should be updated as more information on the watershed is acquired. Recommendations are based on desktop analysis and observations made during targeted upland and stream assessments. While representative sites from across the watershed were assessed, all stream miles and upland areas were not assessed. In the future, additional assessments should be conducted in areas of concern and this *Plan* updated to reflect watershed changes and developments.

# SECTION 2. WATERSHED CHARACTERIZATION

## *2.1 Introduction*

The Wicomico River Watershed (the watershed) is 230 square miles in size located on the lower eastern shore of Maryland (Figure 2. 1). The Wicomico River headwaters drain a small portion of Sussex County, Delaware (1%) with the majority of the watershed contained in Wicomico County (69%) and Somerset County (30%), Maryland. The watershed drains to the Tangier Sound and ultimately the Chesapeake Bay. The diverse watershed is composed of saltwater and freshwater tidal wetlands, productive agricultural land, superior recreational areas for boating, fishing, crabbing and other water-based activities; contains the Monie Bay National Estuarine Research Reserve and a primary navigation hub that is also the Maryland Eastern Shore's biggest city and Maryland's second largest port, Salisbury, MD.

The watershed contains a total of 481 linear stream miles of which 22 percent are impaired (MD DNR, 2012a). The watershed is dominated by agricultural (27%), wetland (25%), forest (18%), and developed (15%) land cover. The agricultural areas contain an extensive drainage ditch system (MDE, 2000b). Wicomico County, MD is the top agricultural producing county in the state that includes beef cattle and leads the state in broiler chicken production with the Perdue Farms Headquarters and processing plant located near Salisbury, MD. Popular crops include corn, soybeans, wheat and vegetables (MD BED, 2012), many of which receive poultry waste as fertilizer.

For this study, the watershed is divided into seven subwatersheds provided in Table 2. 1 and Figure 2. 1. The North Prong drains the headwaters north of Delmar, MD just over the Delaware border. Located near the outlet of North Prong is Johnson Pond a 136 acre impoundment. The pond contains a concrete dam built in 1933 that serves as the designated dividing line between tidal and non-tidal waters in the Wicomico River (MDE, 2001). The pond is a recreational warmwater bass fishery.

Flowing south, the South Prong joins the mainstem to the east of the Salisbury, MD and Tony Tank Creek enters just south of Salisbury, MD. The South Prong is referred to locally as the "East Prong." Tony Tank Lake is an impoundment on Tony Tank Creek that was created in 1948 and is used for recreational purposes. The dam serves as the designated dividing line between tidal and non-tidal waters in Tony Tank Creek (MDE, 1999). Shiles Creek and Wicomico Creek enter the mainstem south of Fruitland, MD. Ellis Bay and Monie Bay contribute to the tidal portion of the River. Monie Bay is a restricted shellfish harvesting area where no harvesting is permitted due to potential contaminated shellfish from bacteria that can make people sick. Monie Bay comprises 3,165 acres that extends from Wingate Point (near the mouth of the Wicomico River) to just beyond Hall Point where Monie Bay meets Tangier Sound. The entire shoreline is comprised of tidal marsh (MDE, 2004).

Local jurisdictions in the watershed have undertaken a number of activities to improve water quality in the Wicomico River. For example, the Town of Delmar and the City of Fruitland have recently completed upgrades to their wastewater treatment plants (WWTP) in order to meet new design standards. The City of Salisbury has also made improvements to its WWTP. The City of

Salisbury has also taken actions to reduce pollution in Beaverdam Creek (South Prong) by installing nets on the outflow pipes as a means to collect debris from the stormwater drainage system. The City of Salisbury and Wicomico County are in the initial stages of creating an urban tree canopy for the purpose of preserving pervious / natural surfaces. These additional tree plantings will remove nutrient contributions from entering local waterways, in addition to the plethora of other benefits that trees provide. More information on local government activities to improve water quality can be found by contacting the governments directly.

**Table 2. 1. Wicomico River Watershed Summary Characteristics**

| Subwatershed | Area (acres) | Jurisdiction (%) | Stream Length (mi) | 303d Stream Miles (% Impaired) | Impervious Cover (%) | Major Land Cover |
|---|---|---|---|---|---|---|
| Monie Bay | 18,448.93 (12.5%) | Somerset Co. (100%) | 78.55 | 0.00 (0.0%) | 0.35 | Evergreen Forest (16.3%), Woody wetlands (24.5%), Emergent Herbaceous wetlands (19.4%) |
| Wicomico Creek | 20,424.44 (13.8%) | Wicomico Co. (39.9%), Fruitland (0.3%), Somerset Co. (59.6%) | 91.65 | 13.38 (14.6%) | 0.84 | Evergreen Forest (14.9%), Woody wetlands (22.6%), Cultured Crop (24.3%) |
| South Prong | 14,816.08 (10.0%) | Wicomico Co. (83.2%), Salisbury (16.8%) | 32.82 | 17.73 (54.0%) | 11.24 | Developed, open space (13.7%), Cultured Crop (24.3%), Woody Wetland (16.9%) |
| Ellis Bay | 28,805.25 (19.5%) | Wicomico Co. (55.1%), Somerset Co. (44.9%) | 113.46 | 7.15 (6.3%) | 0.57 | Open Water (31.6%), Woody wetland (14.5%), Emergent herbaceous wetland (25.7%) |
| Shiles Creek | 21,541.96 (14.6%) | Wicomico Co. (98.5%), Fruitland (0.7%), Somerset Co. (0.7%) | 82.04 | 16.11 (19.6%) | 1.86 | Evergreen Forest (10.8%), Cultured Crop (27.2%), Woody Wetland (17.9%) |
| Tonytank Creek | 18,563.77 (12.6%) | Wicomico Co. (72.8%), Salisbury (15.6%), Fruitland (11.7%) | 37.68 | 9.98 (26.5%) | 9.94 | Developed, open space (16.7%), Cultured Crop (25.9%), Developed, low intensity (10.9%) |
| North Prong | 24,833.91 (16.8%) | Wicomico Co. (75.9%), Salisbury (14.2%), Delmar, MD (4.3%), Delaware Co. (4.3%), Delmar, DE (1.3%) | 44.76 | 41.10 (91.8%) | 7.84 | Developed, open space (10.2%), Cultured Crop (27.2%), Woody Wetland (11.9%) |
| **Total** | **147,434.34** | | **480.96** | **105.45 (21.9%)** | | |

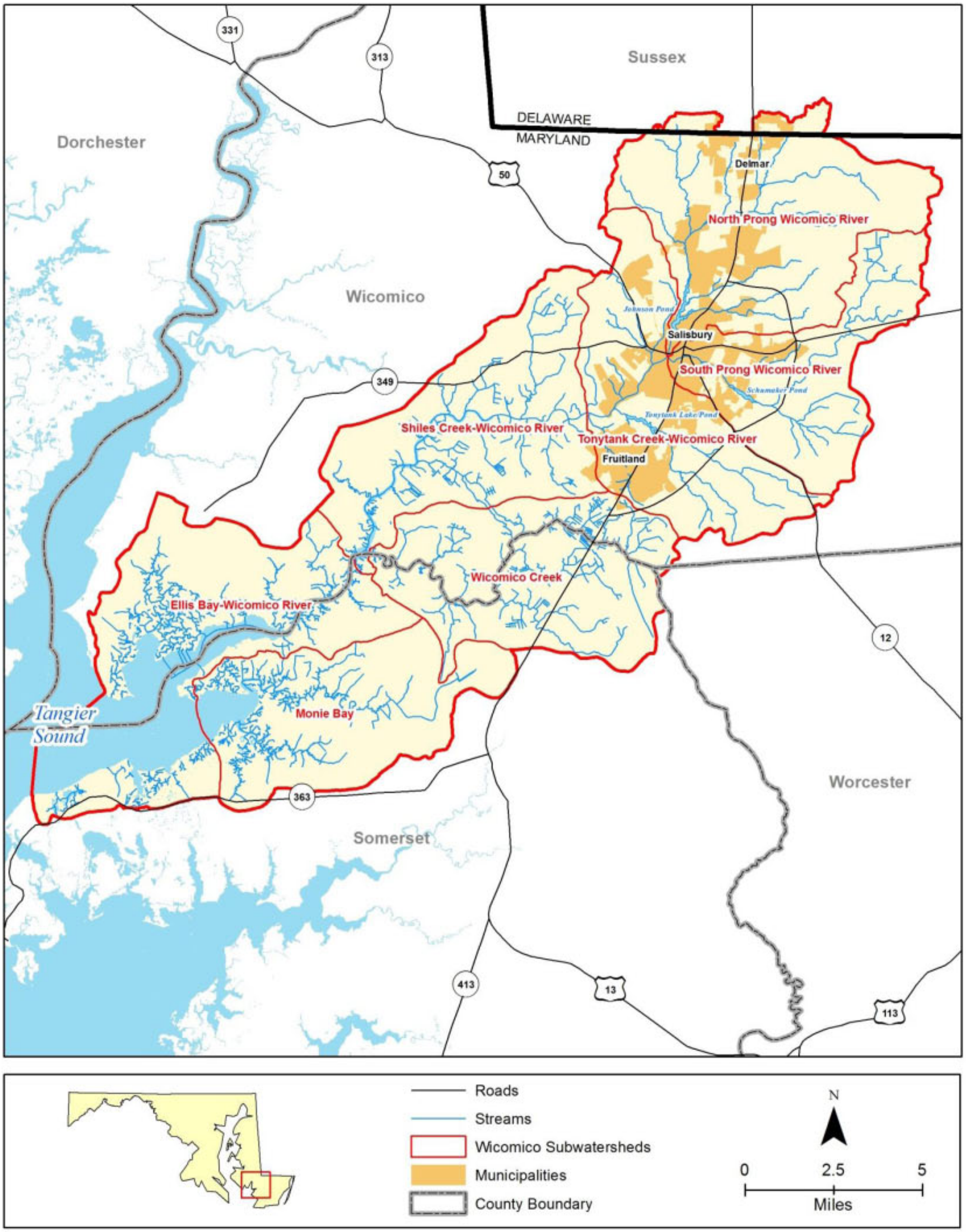



**Figure 2. 1. Wicomico River Watershed**

*2.2 Stream Conditions*

In order to fulfill Clean Water Act, Section 303(d) requirements, all states are required to maintain and update a list of impaired and threatened waters (stream segments) and submit the list to the US EPA for approval every two years. This list is then used to develop total maximum daily loads (TMDLs), which quantify the maximum amount of a pollutant that a waterbody can receive and still meet its designated uses. A TMDL also involves a detailed investigation into the sources of the impairment and reductions required to achieve the TMDL. TMDLs must be developed for every stream listed as impaired on the 303(d) list of the Clean Water Act.

The Chesapeake Bay TMDL was finalized in 2010 by the EPA to restore the Chesapeake Bay and local waterbodies by 2025. This TMDL allocates nutrient and sediment reductions for each bay state and, for Maryland, that includes a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. These reductions were further broken down by county and major river basin. At the state level, Phase 1 Watershed Implementation Plans (WIPs) were developed to determine how each state will help meet pollutant reductions. Phase II WIPs are being developed by each county to outline a strategy to meet pollutant load allocations.

The State of Maryland performed a series of monitoring efforts related to these Clean Water Act requirements. As described in the Code for Maryland Regulations (COMAR) Surface Water Use Designation, Wicomico River is a Use I, defined as water contact recreation and protection of nontidal warmwater aquatic life, and Use II, defined as shellfish harvesting waters. This means that streams in the watershed should be able to support these identified uses.

The Wicomico River watershed is listed as impaired in the Maryland 303(d) list of impaired waters for several pollutants of concern including: Total Phosphorus (2000, 2002, 2012), Sediment/Siltation (2000, 2002), Fecal Coliform (2009), Total Nitrogen (2012), E. Coli (2008), and Total Suspended Solids (2002) (MDE, 2012). To date, there are no TMDL implementation plans developed to address the impairments and meet water quality goals. Table 2. 2 provides a summary of each impairment listing and status. A summary of each TMDL is provided below.

**Table 2. 2. Water Quality Impairment Listing and Status**

| Waterbody | Water Type | Impairment | TMDL Status | Applicable Designated Use |
|---|---|---|---|---|
| Tony Tank Lake | Impoundment | Phosphorus<br>Sediment | TMDL Approved (2000)[1] | Aquatic Life and Wildlife |
| Lower Wicomico River | Chesapeake Bay segment | Total Nitrogen, Total Phosphorus, Biological Oxygen Demand | TMDL Approved (2001) | Water contact recreation, fishing, Aquatic Life and Wildlife, and shellfish harvesting |

| Table 2. 2. Water Quality Impairment Listing and Status | | | | |
|---|---|---|---|---|
| **Waterbody** | **Water Type** | **Impairment** | **TMDL Status** | **Applicable Designated Use** |
| Johnson Pond | Impoundment | Phosphorus Sediment | TMDL Approved (2002) [1] | Aquatic Life and Wildlife |
| Wicomico River Headwaters | Non-tidal 8-digit watershed | Fecal Coliform | TMDL Approved (2006) | Aquatic Life and Wildlife |
| Lower Wicomico River Mainstem | Shellfish Harvesting Area | Fecal Coliform | TMDL Approved (2008) | Shellfish harvesting |
| Wicomico Creek | Chesapeake Bay segment | Total Nitrogen and Total Phosphorus | TMDL Approved (2001) | Water contact recreation, fishing, aquatic life and wildlife |
| Monie Bay | Restricted Shellfish Harvesting Area | Fecal Coliform | TMDL Approved (2010) | Shellfish harvesting |

[1] One TMDL developed for both sedimentation and total phosphorus.

*2.2.1 Total Maximum Daily Loads*

*Johnson Pond Sediment and Phosphorus TMDL (MDE, 2001)*

A single TMDL was developed for phosphorus and sediment for Johnson Pond. The pond has violations of dissolved oxygen below the numeric criteria of 5.0 mg/l. The pond also exhibits nutrient enrichment that results in excessive plant and algae growth that causes odors and impedes direct contact use, fishing, and boating. Finally, the lake has experienced excessive sediment loads that carry phosphorus and have reduced the lake's volume from 62.1 to 41.4 million cubic feet since 1933.

*Tony Tank Lake Phosphorus and Sediment TMDL (MDE, 1999)*

Similar to the TMDL for Johnson Pond, in Tony Tank Lake, a single TMDL was developed for phosphorus and sediments as phosphorus binds to sediment and is transported to the lake. The lake has violations of dissolved oxygen below the numeric criteria of 5.0 mg/l. The lake also exhibits excessive nutrient enrichment resulting in excessive plant and algae growth that causes odors and impedes direct contact use, fishing, and boating. Finally, the lake is experiencing excessive sediment loads. The goals of the TMDL are to maintain a dissolved oxygen concentration that meets state criteria of 5.0 mg/l and reduce phosphorus and sediment loads.

*Lower Wicomico River Total Nitrogen, Total Phosphorus and Biological Oxygen Demand TMDL (MDE, 2000b)*

In the Lower Wicomico River, a TMDL was developed for Total Nitrogen, Total Phosphorus and Biological Oxygen Demand. These impairments have caused eutrophication of the waterbody. Water quality analysis indicates that dissolved oxygen levels often fall below the standard of 5.0 mg/l and chlorophyll a concentrations are above standards. Nonpoint sources and point sources should be controlled to reduce the dissolved oxygen and chlorophyll a concentrations.

*Fecal Coliform TMDLs*

The three fecal coliform TMDLs for the watershed are summarized below. Fecal bacteria are microscopic single-celled organisms found in the wastes of warm-blooded animals. Found in excessive amounts, fecal bacteria are an indicator of an increased risk of pathogen induced illness to humans (MDE, 2006).

*Lower Wicomico River Mainstem Fecal Coliform TMDL (MDE, 2008)*

The Lower Wicomico River mainstem is a designated shellfish harvesting area that was closed due to fecal coliform monitoring that exceeded the water quality criterion. A TMDL for fecal coliform was developed based on the water quality criteria of a median concentration of 14 MPN/100 ml and a 90th percentile concentration of less than 49 MPN/100 ml. Bacteria Source Tracking was conducted to determine the predominant nonpoint sources of fecal coliform.

*Monie Bay Fecal Coliform TMDL (MDE, 2010)*

A TMDL for fecal bacteria was developed for the restricted shellfish harvesting area of Monie Bay (2010). Water quality sampling indicated exceedances of the standards of a median fecal coliform concentration of 14 MPN/100 ml and a 90th percentile concentration of less than 49 MPN/100 ml.

*Wicomico River Headwaters Fecal Coliform TMDL (MDE, 2006)*

A TMDL for fecal bacteria was developed for the Wicomico River Headwaters (2006). Bacteria were attributed to migratory Canadian geese, which are present throughout late fall and early winter, and septic systems. Point sources in the subwatershed include the Delmar Wastewater Treatment Plant (WWTP) and a Perdue industrial and wastewater treatment plant. Poultry litter applications may not present a potential bacteria loading source because local farmers indicate fairly universal application of anhydrous ammonia for fertilizer purposes. Maximum Practical Reduction Targets were established as follows: Human – 95%, Domestic – 75%, Livestock – 75%, and Wildlife – 0%.

*Wicomico Creek Nitrogen and Phosphorus TMDL (MDE, 2000a)*

Wicomico Creek has a TMDL for total nitrogen and total phosphorus based on violations of the dissolved oxygen level criteria for a Use I waterbody. The Use I waterbody supports water contract recreation, fishing, aquatic life and wildlife. The dissolved oxygen criteria for Use I waters is not less than 5.0 mg/l at any time. Due to these conditions, the creek is eutrophic and exhibits nuisance algal blooms in the summer.

### *2.2.2 Biological Conditions*

Biological monitoring data were collected from the Maryland Biological Stream Survey (MBSS). MBSS is a random design stream sampling program intended to provide unbiased estimates of stream conditions with known precision at various spatial scales. Goals of the program are to assess the current condition of ecological resources in Maryland's streams and rivers; identify the impacts of acidic deposition, climate change, and other stressors on ecological resources in Maryland's streams and rivers; provide an inventory of biodiversity in Maryland's streams; assess the efficacy of stream restoration and conservation efforts to stream ecological resources; continue to build a long-term database and document changes over time in Maryland's stream ecological condition and biodiversity status and communicate results to the scientific community, the public, and policy makers.

The fish community data were collected using the MBSS protocols (MDE, 2007). Results of the fish data analysis include a Fish Index of Biological Integrity (FIBI) score based on the fish community characteristics at a sampling site. The benthic macroinvertebrate data were collected using the MBSS protocols. Benthic macroinvertebrates are organisms without a backbone that live on the bottom of streams and can be seen with the naked eye. They are an important part of stream ecosystems as they are a source of food for other aquatic life such as fish. The presence, condition, numbers, and types of benthic macroinvertebrates also convey information about a water body’s quality. Similar to the fish data, results include a benthic Index of Biological Integrity (IBI) score based on the benthic community characteristics at a sampling site. Qualitative ratings of stream biological integrity are based on FIBI and IBI scores and range from good (4.0 – 5.0), denoting minimally impacted conditions, to very poor (1.0 – 1.9), indicating severe degradation. Figure 2. 2, Figure 2. 3, and Appendix A-A provide a summary of the fish community data and benthic macroinvertebrate data for the watershed, respectively.

In the North Prong subwatershed, FIBI and IBI scores range from very poor to good. At the five sites along the Leonard Pond Run, FIBI and IBI scores are similar as they are very poor in the headwaters and increase to good (FIBI score) to very good (IBI score) near the mainstem. Similarly, along the Little Burnt Branch, FIBI scores improve closer to the mainstem from very poor to fair while the IBI scores decline slightly from fair to poor. The Peggy Branch and Middle Neck branch each have one site with good IBI and FIBI scores.

The South Prong subwatershed contains similar FIBI and IBI scores with very poor and poor scores in the headwaters and a fair (FIBI score) and good (IBI score) near the mainstem. The exception is Halloway Branch that has one site in the headwaters scored as poor for IBI and no data for FIBI. Four sampling sites didn't have FIBI data and two didn't have IBI data due to dry stream conditions during sampling.

In the Tony Tank Creek - Wicomico River subwatershed, the Owen's Branch to the north has one site with an IBI score of poor and one site without data while the FIBI along the same branch has a score of good. To the south, the White Marsh Creek has an IBI and FIBI score of poor. The site located in the City of Fruitland at the TonyTank Pond has both an IBI and FIBI score of good. There is one site along Cox Branch without data.

Shiles Creek subwatershed has one site located on Rockawalkin Creek with an IBI and FIBI score of poor.

The Wicomico Creek subwatershed also has one site that is located on the Passerdyke Creek with an IBI score of poor and an FIBI score of fair. There are no IBI or FIBI sites in both the Monie Bay and Ellis Bay subwatersheds.

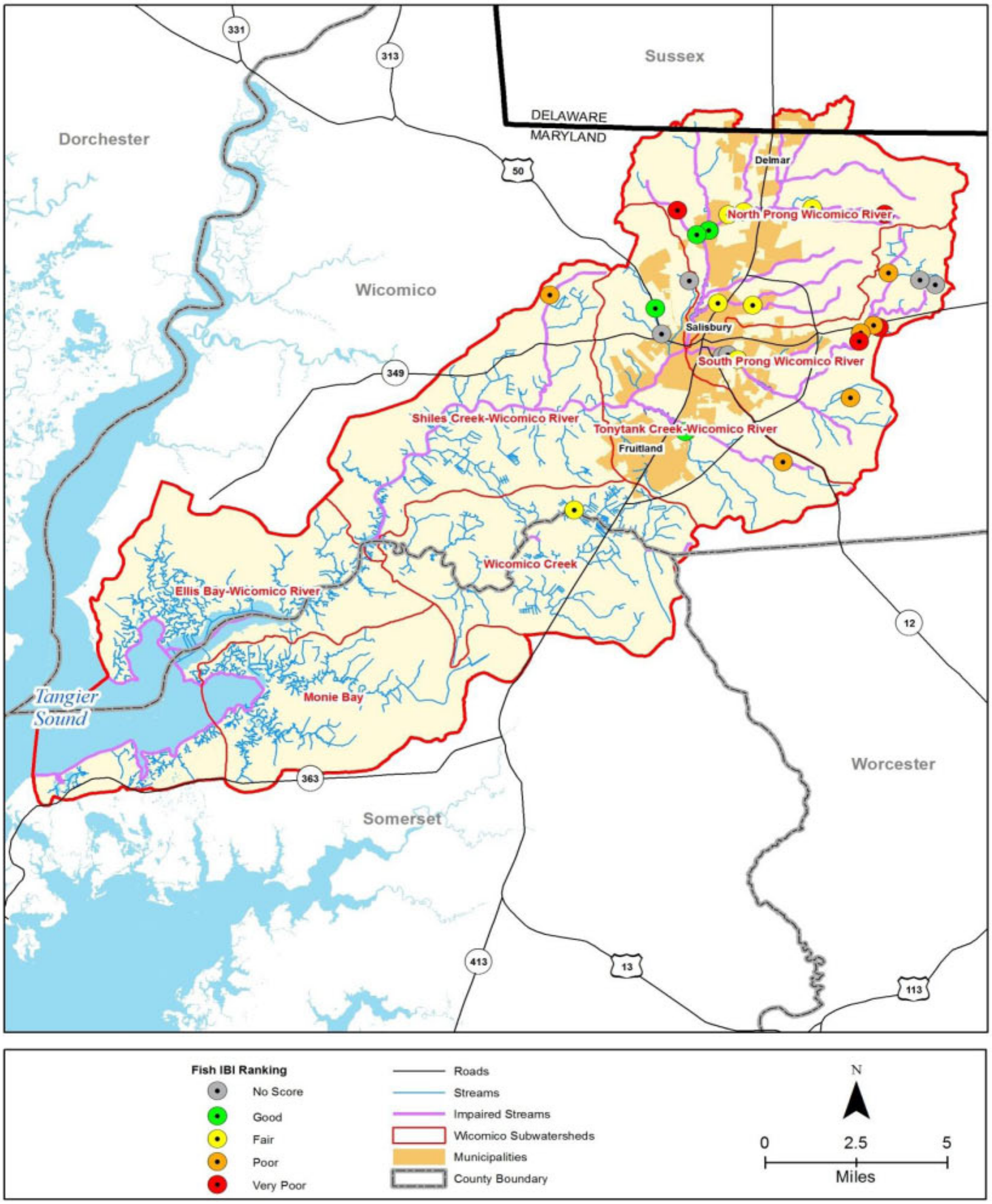



**Figure 2. 2. Location and Ranking of Fish Index of Biological Integrity (FIBI) Sites**

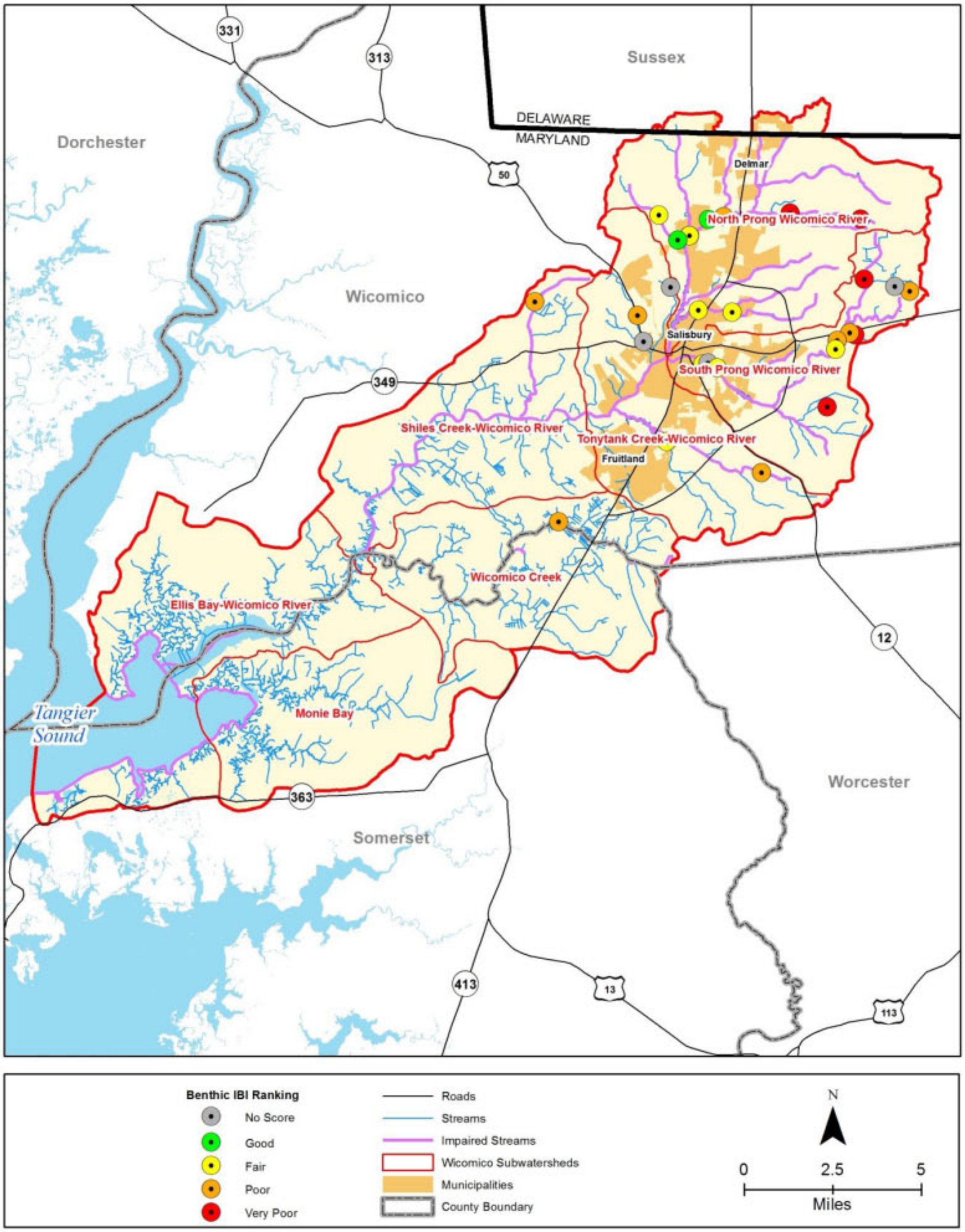



**Figure 2. 3. Location and Ranking of Benthic Macroinvertebrate Index of Biological Integrity (IBI) Sites**

### *2.2.3 Water Quality Conditions*

The Wicomico Creekwatchers program is a community partnership between the Chesapeake Bay Foundation (CBF), Wicomico Environmental Trust, the City of Salisbury and Salisbury University. The program's mission is to collect and develop objective, scientifically-credible water quality data through a grassroots volunteer force that monitors the waters of the Wicomico River and its tributaries. The program works to ensure that public policies and other management tools adequately protect and preserve Wicomico River water quality. Since its inception in 2002, the program has begun to establish a set of baseline data for identifying water quality conditions and trends over time. Volunteers collect samples from 25 sites on the Wicomico river mainstem, several Wicomico tributaries and dammed water features (Salisbury University, 2010). For this study, six of the Creekwatcher sample sites were chosen to represent water quality conditions for six of the seven subwatersheds (Table 2. 3). Monie Bay was excluded from this analysis as no Creekwatcher sample site exists in this subwatershed. Using 2010-2011 Creekwatcher data, average monthly total nitrogen (TN) and total phosphorus (TP) values were analyzed for these six sites, as shown in Figure 2.4 and Figure 2.5, respectively. Sharps Point only consists of 2011 data as no data was available for 2010. The water quality thresholds provided by Delaware Department of Natural Resources and Environmental Control for TN and TP are shown in Table 2. 4.

**Table 2. 3. Subwatersheds and Representative Creekwater Sample Sites**

| Subwatershed | Creekwatcher Sample Site |
|---|---|
| North Prong | South Johnson Pond |
| South Prong | East Branch Downtown |
| Tony Tank | Sharps Point |
| Shiles Creek | Geipe |
| Wicomico Creek | Yacht Club |
| Ellis Bay | Mount Vernon |
| Monie Bay | N/A[1] |

**Table 2. 4. Water Quality Thresholds (mg/l)**

| | Healthy Value | Moderate Value | High Value |
|---|---|---|---|
| Total Nitrogen | <1 | 1 - 3 | ≥3 |
| Total Phosphorus | <0.05 | 0.05 - 0.1 | ≥0.1 |

[1] No Creekwatcher sample site exists for this subwatershed.

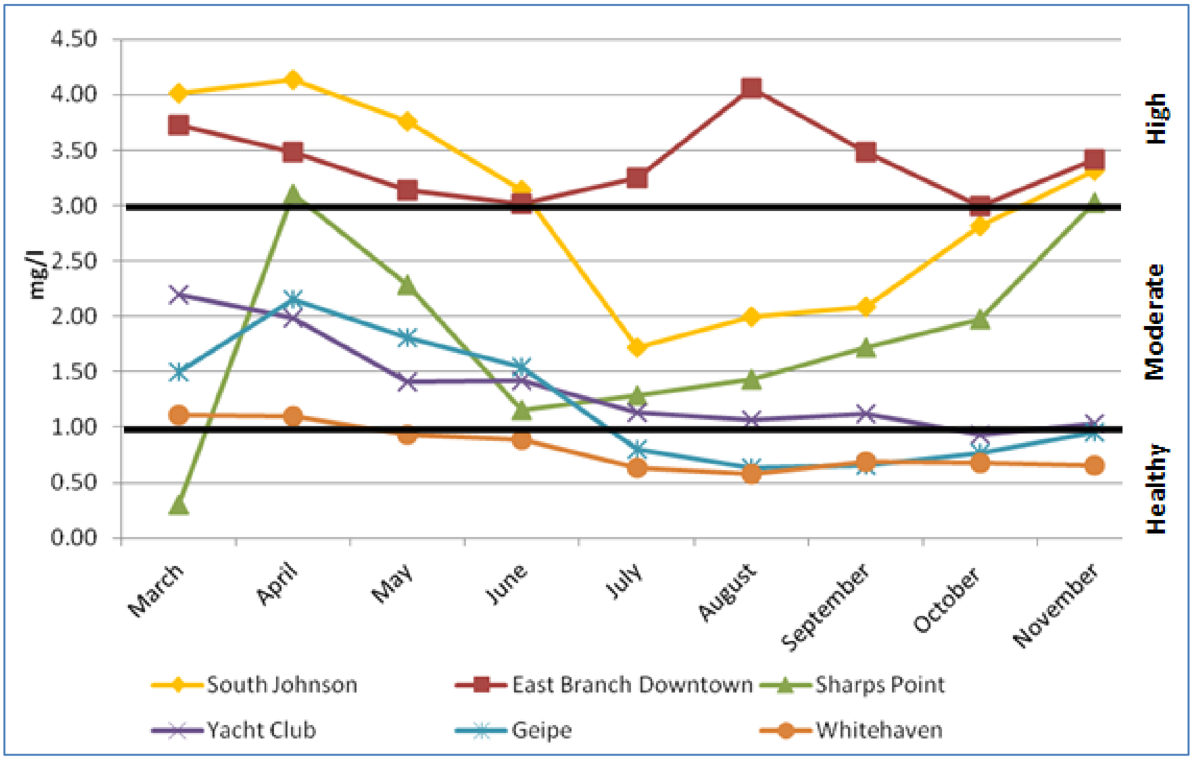



**Figure 2. 4. Average Monthly Total Nitrogen Concentration (mg/l)**

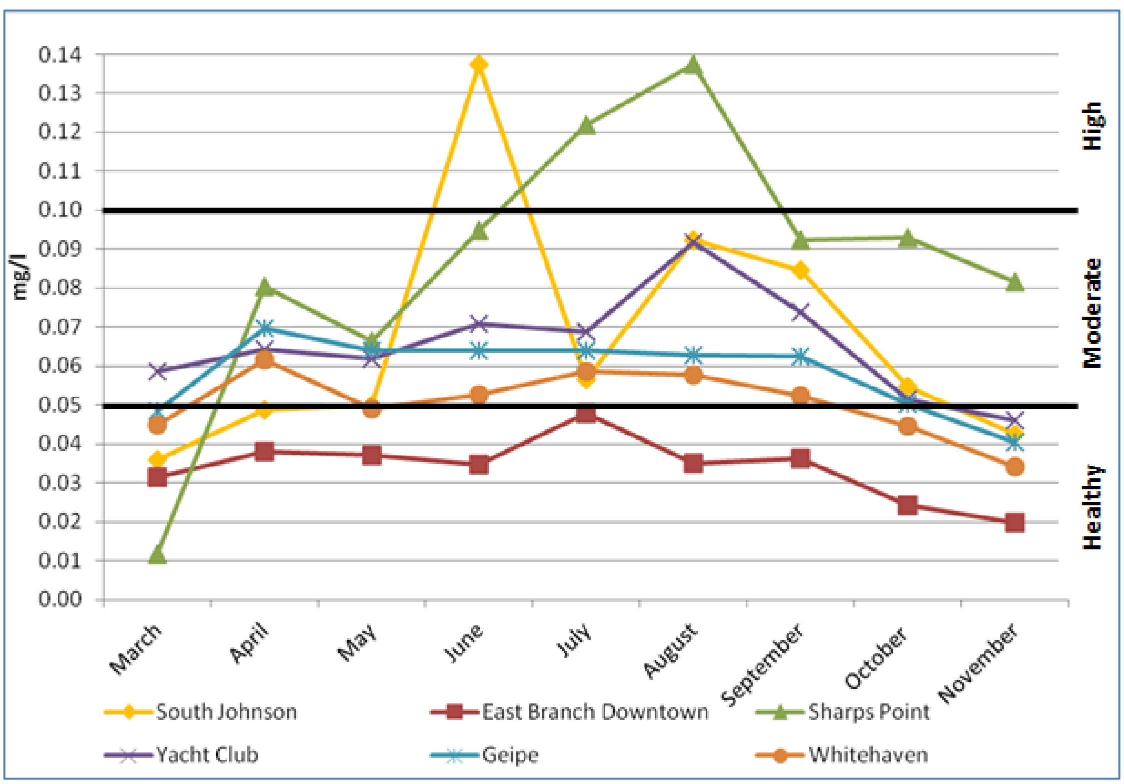



**Figure 2. 5. Average Monthly Total Phosphorus Concentration (mg/l)**

Figure 2.4 shows that in general, average monthly total nitrogen (TN) values are higher in the spring, lower in the summer months and levels off or increases in the fall. Except for the months of March and April, Whitehaven sampling station is within the TN healthy value threshold of below 1 mg/l. Sampling station Geipe, is within the healthy value threshold from July to November. East Branch Downtown sampling station and South Johnson sampling station (March – June) are above the TN high value threshold of 3 mg/l. All other sampling station sites are within the moderate value threshold values from 1 to 3 mg/l.

Figure 2.5 shows in general, average monthly total phosphorus (TP) values increase in the summer months. East Branch Downtown sampling station is the only station below the TP healthy value threshold of below 0.05 mg/l. With the exception of a few monthly samples for South Johnson and Sharps Point, the other sampling stations fall within the TP moderate value threshold from 0.05 to 0.1 mg/l.

Figure 2. 6 and Figure 2. 7 show the locations of the Creekwatcher sample sites. In addition, for the six selected sites, the figures summarize the percent number of samples whose values fall within the water quality thresholds for TP and TN, respectively. The figures show that sites in the headwaters have more samples with a high value threshold. More samples with a healthy value threshold are located in the lower watershed.

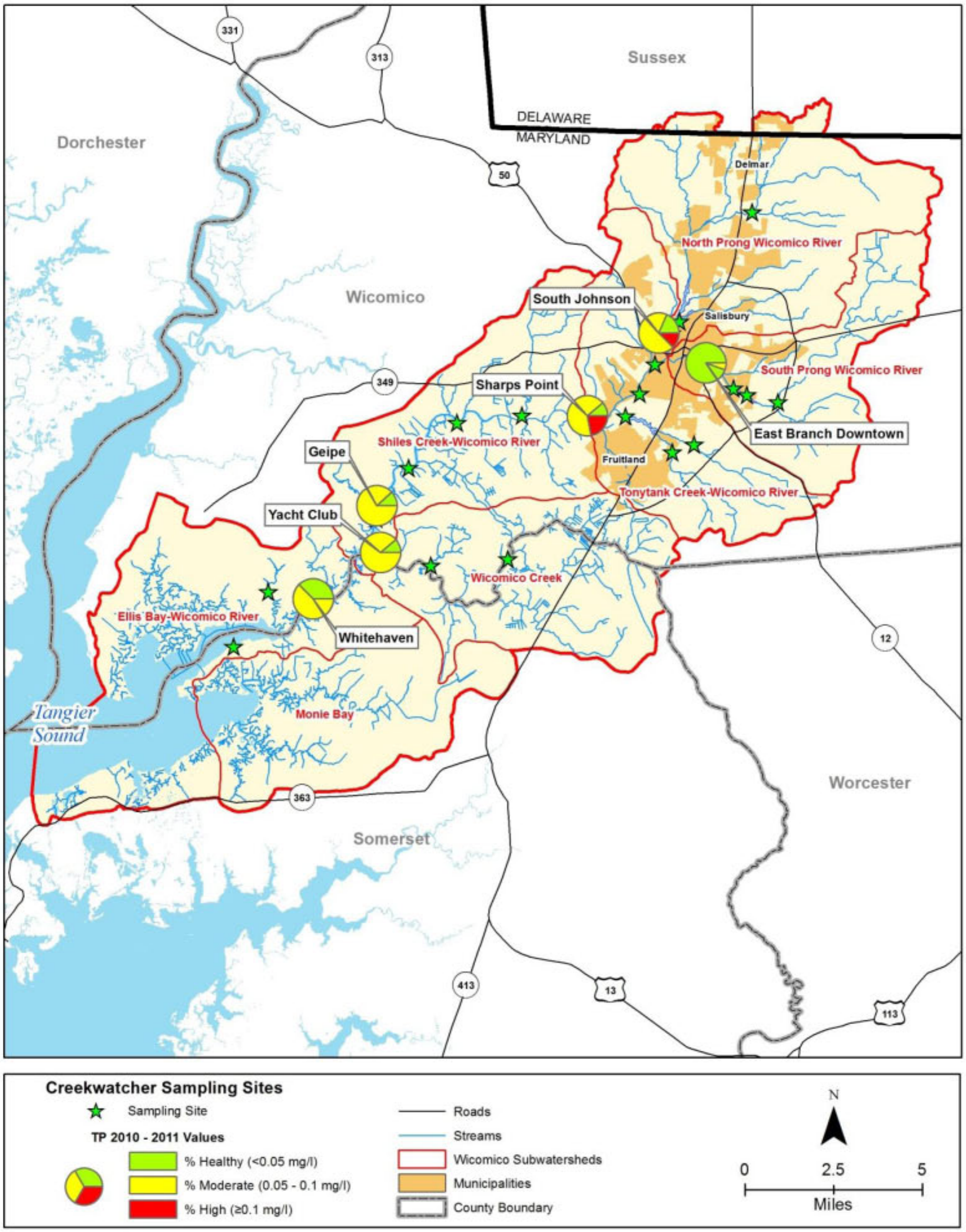



**Figure 2. 6. Total Phosphorus Values for Selected Creekwatcher Sampling Sites**

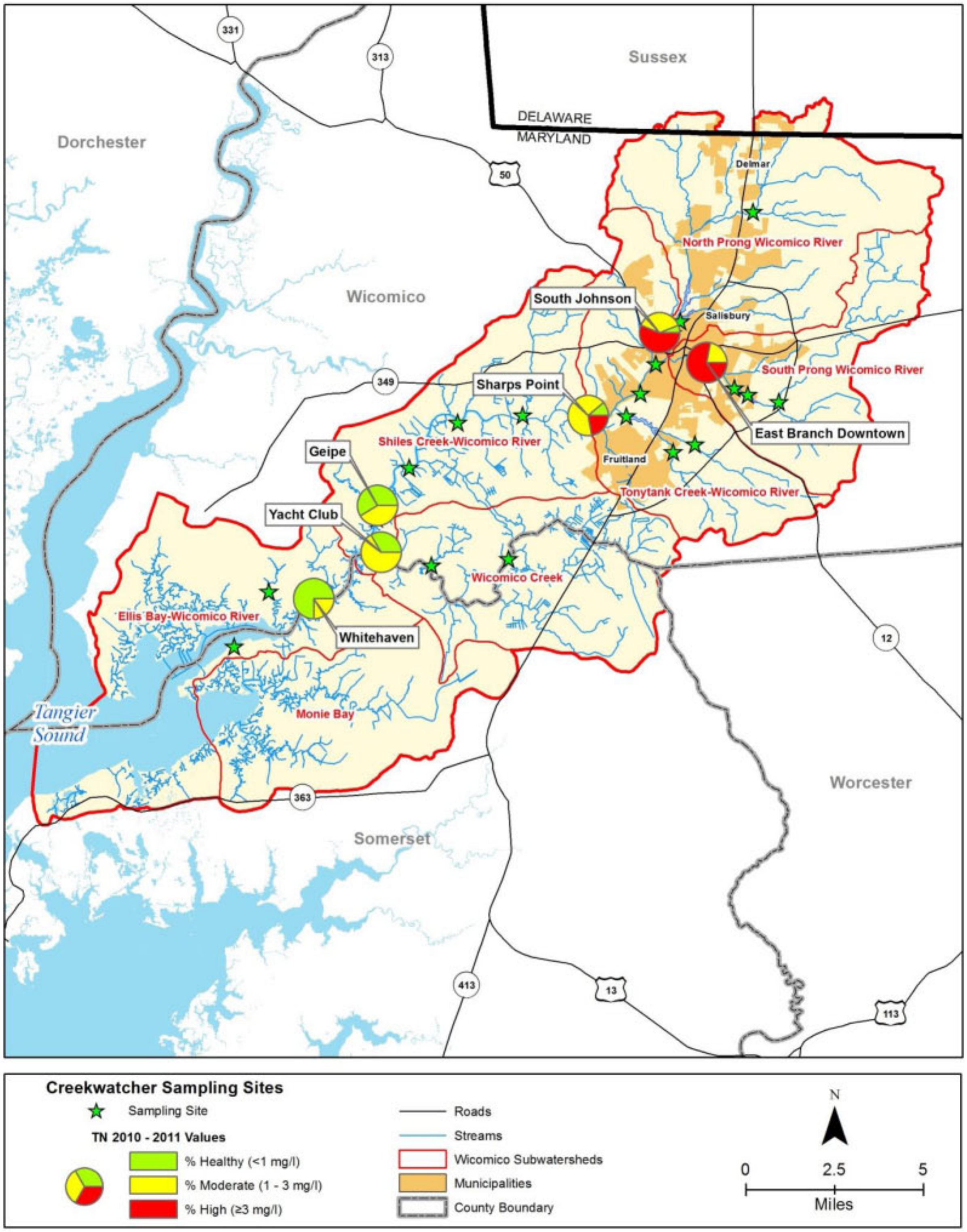



**Figure 2. 7. Total Nitrogen Values for Selected Creekwatcher Sampling Sites**

### *2.2.4 Sources of Impairment*

#### *TMDL Sources of Impairment*

Nonpoint and point sources are identified as contributors of pollutants in the TMDLs for the watershed. In the Tony tank lake phosphorus and sediment TMDL, management strategies should be focused on reducing nonpoint sources, since this is the dominant contributor of pollutants, and on agricultural land, since this land use contributes 55% of the phosphorus load (MDE, 1999). A combination of both structural and nonstructural best management practices (i.e. stream side buffer strips) can significantly reduce sediment loads. Similarly, the Johnson Pond phosphorus and sediment TMDL should focus on a 53% reduction in point sources and a 49% reduction in nonpoint sources. Management strategies for the point sources include the requirement of Chemical Phosphorus Removal (CPR) in the NPDES permits for the Delmar WWTP and Perdue Farms, Inc. WWTP. Nonpoint source management should focus on agricultural BMPs as this land use makes up 41% of the land use (MDE, 2001). In the Lower Wicomico River TMDL for Total Nitrogen, Total Phosphorus and Biological Oxygen Demand, there are two significant point sources, the Salisbury Wastewater Treatment Plant and the Fruitland Wastewater Treatment Plant.

The Wicomico Creek TMDL for nitrogen and phosphorus identified no point sources and identified nonpoint sources to include groundwater, agricultural ditching, animals in the stream, and deposition of nutrients and organic matter to the stream bed from high flow events (MDE, 2000a).

There are three fecal coliform TMDLs in the watershed in the Lower Wicomico River mainstem, Monie Bay and Wicomico River headwaters. In the Lower Wicomico River bacteria source monitoring identified the dominant source of fecal coliform from wildlife (44.1%), followed by unknown/unclassified (20.4%), human (20.1%), livestock (9.5%) and pets (5.9%) (MDE, 2008). In the Monie Bay, potential nonpoint sources of fecal bacteria include manure spreading, direct deposition from livestock, failing septic systems, and excretions from pets and wildlife. Bacterial Source Monitoring was conducted to determine the sources of bacteria in the watershed. The monitoring results show that the majority of the bacteria is from human (28.69%) and wildlife (28.55%), followed by livestock (25.5%) and pets (17.26%) (MDE, 2010). There are no point sources in the watershed. There are many types of nonpoint sources of fecal bacteria identified in the Wicomico River Headwater fecal coliform TMDL. These include manure spreading, direct deposition from livestock during the grazing season, excretions from pets and wildlife, failing septic systems and leaking infrastructure (i.e. sewer systems). Sources near the Leonard Mill Pond include a large Canadian Geese population and septic systems. Sources between Leonard Mill Pond and Johnson Pond include the Leonard Mill Visitor Center that contains a large pet exercise area and the banks of Leonard Mill Run, which contains a goose population.

Sanitary Sewer Overflows (SSO) occur when the capacity of a separate sanitary sewer is exceeded. According to MDE (2006), there were a total of four SSOs reported between 2001 and 2003 that resulted in the discharge of approximately 60,200 gallons of sanitary sewer overflow to the river. In 2005, new regulations were instated regarding reporting and public notification of sewer overflows and wastewater treatment plant bypasses. According to the Maryland Reported Sewer Overflow Database, there have been 95 SSOs between 2005 and 2012 in the Wicomico River, discharging approximately 20.84 million gallons of untreated sewage into the river.

Bacterial Source Monitoring was conducted to determine the sources of bacteria in the watershed. The monitoring results show that the majority of the bacteria are from wildlife (mammals and waterfowl) and domestic uses (pets and septic systems). Based on the TMDL modeling, in three of the five watersheds, where the wildlife contribution is significant, the bacteria reduction to achieve water quality standards could not be achieved.

Implementation of the fecal coliform TMDLs should not focus on removing wildlife but instead address controllable sources first with the understanding that they might also reduce wildlife sources (MDE, 2010).

Illicit discharges are another potential source of bacteria to the watershed. The Center conducted illicit discharge detection and elimination (IDDE) staff training and outfall screening with the City of Salisbury in 2011. The study found 40% of screened outfalls with dry weather flow and 23% of those outfalls with dry weather flow had E. coli concentrations above the EPA's standard for water contact recreation (235 CFU/100 ml for a grab sample) (CWP, 2011). In addition, very high concentrations of total coliforms were seen in many outfalls as well (Figure 2. 8).

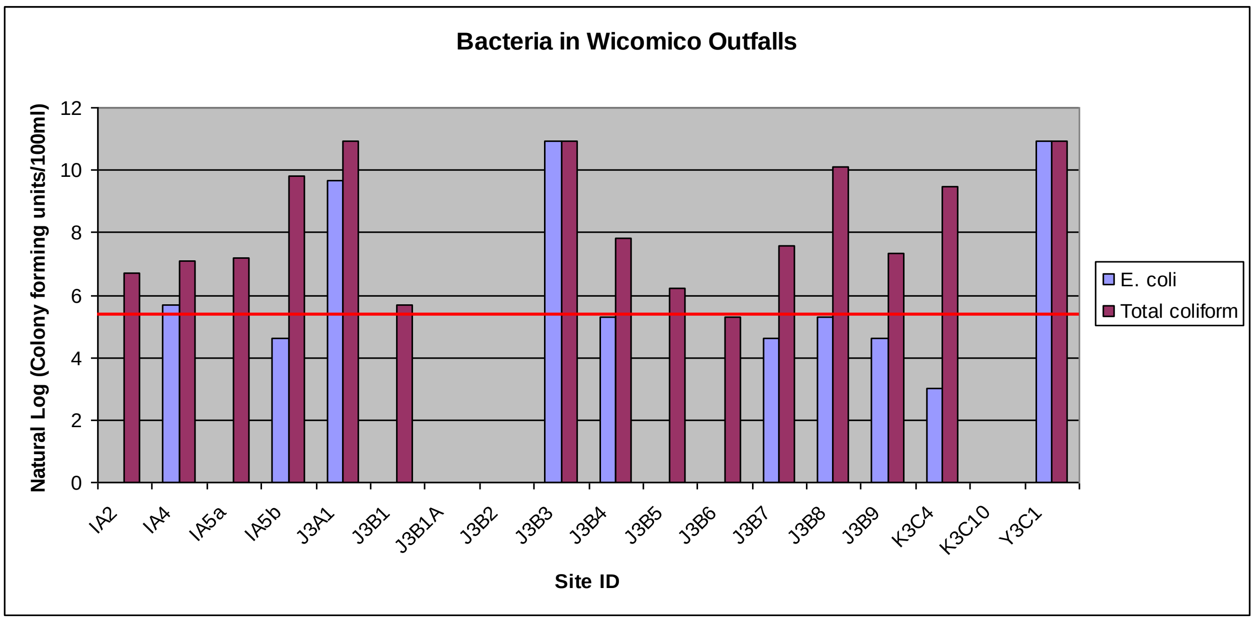



**Figure 2. 8. E.coli and Total Coliform Concentrations in Salisbury Outfalls**

*Point Sources*

Facilities that discharge municipal or industrial wastewater or conduct activities that can contribute pollutants to a waterway are required to obtain a National Pollutant Discharge Elimination System (NPDES) permit. The number and type of NPDES-permitted facilities within the watershed is summarized in Appendix A-B. Data was obtained from the US EPA Enforcement and Compliance History Online (ECHO) website (http://www.epa-echo.gov/echo/) on 3/23/2012. There are a total of 39 NPDES permits in the watershed with 34 located in Salisbury, MD; two each in Fruitland, MD and Eden, MD; and one in Delmar, MD. Table 2. 5 provides a summary of the types of the Major and Minor NPDES individual permits located in the watershed.

**Table 2. 5. Summary of Major and Minor NPDES Individual Permits**

| Jurisdiction | NPDES Individual Permit | Major | Minor |
|---|---|---|---|
| Salisbury, MD | City of Salisbury Wastewater Treatment Plant (WWTP) | X | |
| | Perdue Farms | X | |
| | Delmarva Oil | | X |
| | Former Dresser Salisbury Facility | | X |
| | Holly Center | | X |
| | Naylor Mill Road Regional Lift Station | | X |
| | Nustar Terminals Operations Partnership L.P. | | X |
| | Salisbury Portable Water Storage Tank | | X |
| | Sherwood Ford Lincoln Mercury | | X |
| | Sherwood of Salisbury Appearance Center | | X |
| Fruitland, MD | Fruitland WWTP | | X |
| | Hearne-Meadow, LLC | | X |
| Delmar, MD | Delmar WWTP | | X |

## *2.3 Natural Resources*

### *2.3.1 Ecological Areas*

The Wicomico River contains an abundance of natural resources that include sensitive species, targeted ecological areas, forest interior dwelling species potential habitat, biodiversity conservation network, wetlands of special state concern, green infrastructure hubs and corridors, and critical areas. The data was calculated for the Maryland portion of the watershed and obtained from Maryland Department of Natural Resources (MD DNR) (MD DNR, 2012a). Similar data was not available for Delaware. A description of each natural resource category follows.

- Sensitive species: The statewide file shows buffered areas that primarily contain habitat for rare, threatened, and endangered species (RTE) and rare natural community types. This data layer was originally created to provide information to local jurisdictions and state agencies to assist with assessing environmental impacts and reviewing potential development projects or land use changes.

  Specific data on RTE species was obtained from the Maryland DNR. Table 2. 6 provides a summary of the RTE plant and animal species found within the watershed. Several species are indicated as critically imperiled in Maryland because of extreme rarity or some factor making it especially vulnerable to extirpation. These species are actively tracked by the Natural Heritage Program.

| Table 2. 6. Summary of RTE Plant and Animal Species | |
|---|---|
| **Common Name** | **Type** |
| American Chestnut | Vascular Plant |
| Bald Eagle | Vertebrate Animal |
| Banded Sunfish | Vertebrate Animal |
| Coastal Butterfly-pea | Vascular Plant |
| Dotted Water-meal | Vascular Plant |
| Dwarf Iris* | Vascular Plant |
| Gibbous Panic-grass* | Vascular Plant |
| Hairy Snoutbean | Vascular Plant |
| Long's Bittercress* | Vascular Plant |
| Mitchell's Sedge | Vascular Plant |
| Pale Bluet* | Invertebrate Animal |
| Parker's Pipewort | Vascular Plant |
| Robbins' Spikerush* | Vascular Plant |
| Seaside Alder | Vascular Plant |
| Shining Nutrush* | Vascular Plant |
| Showy Aster* | Vascular Plant |
| Slender Blue Flag* | Vascular Plant |
| Vulnerable Species[2] | Vulnerable Species |
| White-bract Thoroughwort | Vascular Plant |
| Woolly Witchgrass* | Vascular Plant |

* Critically imperiled in Maryland.

- Targeted ecological areas - A limited number of areas that rank exceptionally high for ecological criteria and that have a practical potential for preservation.
- Forest interior dwelling species potential habitat - Potential habitat layer for Forest Interior Dwelling Species (FIDS) developed from the results of a model depicting where FIDS habitat might occur to provide protection of these species.
- Biodiversity conservation network (BioNet) - identifies and prioritizes ecologically important lands to conserve Maryland’s biodiversity (i.e., plants, animals, habitats, and landscapes). This dataset aggregates numerous separate data layers hierarchically according to the BioNet Criteria Matrix (MD DNR, 2012c).
- Wetlands of special state concern - In Maryland certain wetlands with rare, threatened, endangered species or unique habitat receive special attention. In general, the US Fish and Wildlife Service's National Wetlands Inventory provides the basis for identifying these special wetlands. Additional information, determined from field inspections, is used to identify and classify these areas.
- Green Infrastructure Hubs and Corridors - Maryland’s green infrastructure is a network of undeveloped lands (wetlands, forest and other natural lands) that provide ecosystem

[2] Due to Maryland’s vulnerable species policy, the common names of several species were not provided to help ensure additional protection. These are listed as ‘vulnerable species’.

services such as filtering water, marketable goods and services like forest products and vital habitat for wild species. The hubs are large continuous areas containing these resources while corridors are linear corridors that provide connectivity between hubs.

- Critical Areas - The Critical Area is all land and water areas within 1000 feet of the tidal waters' edge or from the landward edge of adjacent tidal wetlands and the lands under them. In 1984, the Chesapeake Bay Critical Area Act was created to regulate development, manage land use and conserve natural resources on land in those areas designated as Critical Area.

The total acres of ecological areas for each subwatershed are shown in Table 2. **7**, titled ‘Combined Ecological Areas’ and consists of over half (56.6%) of the watershed. The regulated areas consist of wetlands of special state concern and critical areas that together make up 13% of the ecological areas. The remaining ecological areas are used for planning and permit review during the development process. Of all the subwatersheds, the Wicomico Creek contains the most acres of ecological areas at 79 percent with the Monie Bay in close second at 74 percent. The Tonytank creek is the most developed subwatershed and contains the least amount of ecological areas with 29 percent.

**Table 2. 7. Summary of Percent Ecological Areas in Wicomico River Watershed**

| | Sensitive Species (%) | Targeted Ecological (%) | Forest Interior Dwelling Species Potential Habitat (%) | Biodiversity Conservation Network (%) | Wetlands of Special State Concern (%) | Green Infrastructure Hubs and Corridors (%) | Critical Area (%) | Combined Ecological Area (%) |
|---|---|---|---|---|---|---|---|---|
| **Monie Bay** | 10.6 | 20.0 | 31.9 | 34.8 | 0.0 | 68.9 | 0.0 | 74.2 |
| **Wicomico Creek** | 19.6 | 59.9 | 35.4 | 47.5 | 0.2 | 64.5 | 4.8 | 78.9 |
| **South Prong** | 7.0 | 13.3 | 19.6 | 21.3 | 0.3 | 13.0 | 1.4 | 35.9 |
| **Ellis Bay** | 3.8 | 44.1 | 17.3 | 17.8 | 0.0 | 58.6 | 11.7 | 62.7 |
| **Shiles Creek** | 13.7 | 36.9 | 26.2 | 30.2 | 1.1 | 56.2 | 20.5 | 66.8 |
| **Tonytank Creek** | 9.2 | 3.0 | 13.0 | 15.7 | 0.8 | 9.7 | 6.0 | 28.9 |
| **North Prong** | 16.6 | 0.0 | 26.8 | 29.6 | 0.2 | 29.6 | 0.4 | 42.3 |
| **Watershed Total** | 11.4 | 26.5 | 24.2 | 27.9 | 0.3 | 44.7 | 6.9 | 56.6 |

### *2.3.2 Protected Lands*

Protected lands were summarized for the watershed from several GIS layers obtained from MD DNR (2012a). Protected land data was not available for the Delaware portion of the watershed. This data includes protected lands owned by the County and various conservation easements. A conservation easement ensures the protection of significant natural resources on a property by removing the development rights of the property. Placing a property under easement may allow the landowner to receive income, or estate and property tax benefits while still maintaining ownership of the property.

The Wicomico River watershed contains several types of protected lands held under various preservation programs described in more detail below. Table 2. 8 summarizes the area of protected land within each subwatershed. A description of each category of protected land follows. In addition, Wicomico County Code requires subdivisions located within the Agricultural – Rural Zoning District to set aside 50 percent of the total land area as preserved open space (Keith Hall, pers. comm).

**Table 2. 8. Summary of Protected Land in Wicomico River Watershed**

| | Area (Acres) | Protected Land Area (Acres) | Protected Land Area (%) |
|---|---|---|---|
| Monie Bay | 18,448.93 | 6,303.55 | 34.17 |
| Wicomico Creek | 20,424.44 | 4,423.22 | 21.66 |
| South Prong | 14,816.08 | 258.07 | 1.74 |
| Ellis Bay | 28,805.25 | 7,209.96 | 25.03 |
| Shiles Creek | 21,541.96 | 1,317.57 | 6.12 |
| Tonytank Creek | 18,563.77 | 306.80 | 1.65 |
| North Prong | 24,833.91 | 1,385.15 | 5.58 |
| Watershed Total | 147,434.34 | 21,204.32 | 14.38 |

- Agricultural land preservation foundation easements - This program is dedicated to preserving farmland and promoting commercial agriculture. To qualify for this program, a farm must be a minimum of 50 acres or located adjacent to a preserved property.
- Environmental trust easements – This is a statewide local land trust with the main goal of preservation of open land, such as farmland, forest land, and significant natural resources. The primary tool for doing this is the conservation easement.
- Forest conservation easements – Contains the conserved and planted forest areas required by the Forest Conservation Act.
- MD DNR lands and conservation easements – Contains the public lands and protected open space owned by MD DNR.
- Private conservation easements – Contains properties that are protected from development by ownership of a private conservation group or society.

- Protected county lands – Consists of land areas that are run and maintained by county and municipal authorities.

The single largest protected area in the watershed is located in the Monie Bay Subwatershed. Here, the 3,426 acre Monie Bay National Estuarine Research Reserve (the Reserve) is located on the Deal Island Peninsula in Somerset County, MD. The Reserve is comprised of wetland creeks and rivers, marshes, scrub-shrub wetlands, forested wetlands, forested uplands and coastal grasslands.

Fish species occurring in the numerous tidal creeks in the Reserve include mummichog, white perch, spot and menhaden. Common invertebrates include fiddler and blue crabs, American oysters, marsh periwinkles and common grass shrimp (NERRS, 2012). Shellfish waters in Monie Bay extend from Wingate Point (near the mouth of the Wicomico River) to just beyond Hall Point where Monie Bay meets Tangier Sound (MDE, 2004). There is also an abundance of resident and migratory bird populations, including bald eagles, osprey and numerous hawk species. Waterfowl species include Canada geese, mallards, black ducks and green-winged teals. Birds of interest spotted in the Reserve include the hooded merganser, the sora rail, the American bittern, the pied-billed grebe, the marsh hawk, the sedge wren, the least tern, the common gallinule and the least bittern (NERRS, 2012).

### *2.4 Classification of Subwatersheds*

Subwatersheds were classified based on protection and restoration needs to identify broad goals and strategies for each subwatershed type. Since the watershed includes several jurisdictions (Wicomico and Somerset Counties and City of Salisbury in MD, Sussex County in DE), one limiting factor is the need to use data layers that are available for all jurisdictions.

A simple proposed subwatershed management classification was developed based on the Center's Impervious Cover Model, but modified to account for the rural nature of portions of the watershed (e.g., the approach considers that impairments may be the result of urbanization or agricultural activities). The exact metrics used depended on data availability. The thresholds for determining the classification are primarily determined based on the spread of the data using the quartile approach. Table 2. 9 provides the definition, management strategies and subwatersheds included for each management classification.

**Table 2. 9. Subwatershed Classification and Management Strategies**

| Management Classification | Definition | Management Strategies |
|---|---|---|
| Ecological (Monie Bay, Ellis Bay) | <5% Impervious cover<br>>60% forested/wetland and <25% crop and pasture land<br>>40% targeted ecological areas | Attempt to ensure the preservation of important ecological areas, sensitive streams, wetlands, and contiguous forest.<br>Protect agricultural and forest lands and work on the long-term protection and sustainable |

**Table 2. 9. Subwatershed Classification and Management Strategies**

| Management Classification | Definition | Management Strategies |
|---|---|---|
| | | management of these resources. |
| Sensitive Rural (Wicomico Creek, Shiles Creek) | <5% Impervious cover<br><60% forested/wetland and >25% crop and pasture land<br>10-25% stream length impaired | Protect agricultural and forest lands and work on the long-term protection and sustainable management of these resources. Reduce pollutant sources, restore degraded streams and protect streams from further degradation. |
| Impacted Rural / Urban Mix (North Prong) | 5-10% Impervious cover<br><60% forested/wetland and >25% crop and pasture land<br>>25% stream length impaired | Protect agricultural and forest lands and work on the long-term protection and sustainable management of these resources. Target growth to most appropriate areas.<br><br>Reduce pollutant sources, restore degraded streams and protect streams from further degradation. |
| Impacted Urban (South Prong, Tonytank Creek) | ≥10% Impervious cover<br>>25% stream length impaired | Target expected growth to most appropriate areas, while preventing significant degradation from occurring in the future from additional new development. Reduce pollutant sources, restore degraded streams and protect streams from further degradation. |

Priority subwatersheds for protection are those that have a lot of sensitive and important natural features, good water quality and are vulnerable to impacts from development or other land use activities. Priority subwatersheds for restoration are those that are impacted (but not so impacted that they cannot be restored) and have a lot of opportunities to install restoration projects. The metrics and scoring rules used to rank each subwatershed for protection and restoration are provided in Appendix A-C, the final ranking scores are provided in Appendix A-D and map is shown in Figure 2. 9.

The same data was used to select the subwatershed to conduct field investigations for the development of a subwatershed action or implementation plan. The Core Team decided to conduct initial field investigations in subwatersheds identified for restoration activities.

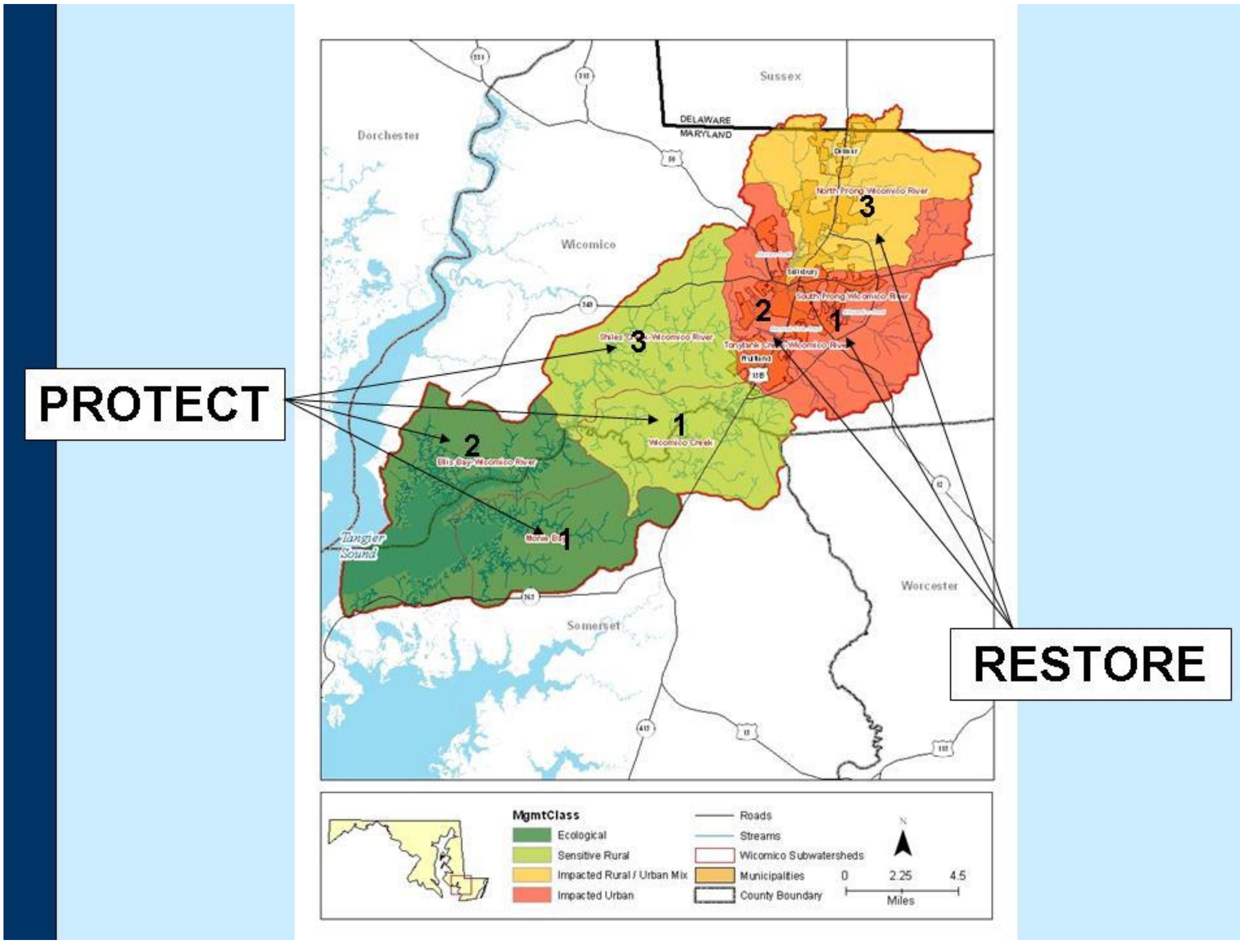



**Figure 2. 9. Protection and restoration subwatershed priorities as identified by the Core Team**

### *2.5 Sea Level Rise*

Maryland's Lower Shore region is extremely vulnerable to sea level rise (SLR) from climate change. Maryland's A Sea Level Rise Response Strategy for the State of Maryland (Johnson, 2000) states the problem for Maryland and the Lower Shore is as follows, "The average rate of SLR along Maryland's coastline has been 3-4 mm/yr, or approximately one foot per century. Such rates are nearly twice those of the global average (1.8mm/year), a result probably due to substantial land subsidence. Furthermore, research has demonstrated that SLR rates will accelerate in response to global warming, resulting in a rise of 2 to 3 feet by the year 2100 (Leatherman et al., 1995). A rise in sea level of this magnitude will undoubtedly have a dramatic effect on Maryland's coastal environment." GIS data was obtained from Maryland Department of Natural Resources (DNR) on sea level rise inundation vulnerability. Three inundation scenarios are portrayed in Figure 2. 10. Adaptive management strategies, specific actions, costs, and timelines are needed in local communities such as on the Lower Shore where significant impacts are expected. More information concerning sea level and local impact can be found on MD DNR's web site: http://www.dnr.state.md.us/climatechange/.

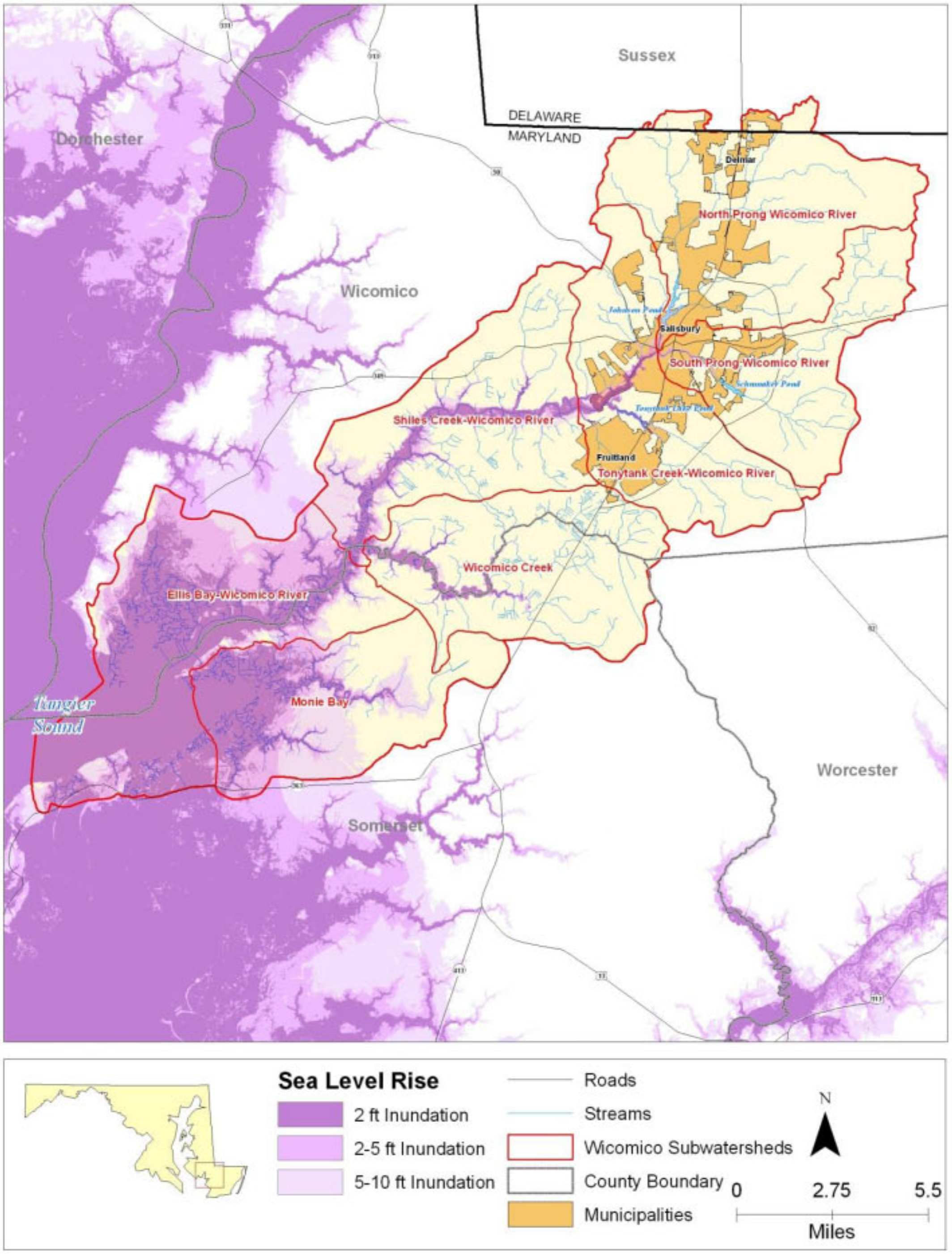



**Figure 2. 10. Sea level rise inundation scenarios for the Wicomico River watershed**

# SECTION 3. WATERSHED ASSESSMENT PROTOCOLS

## *3.1 Introduction to the Watershed Assessment*

The watershed assessment protocols used during this study are based on a series of manuals written by the Center to restore small urban watersheds and compiled into a format that can easily be accessed by watershed groups, municipal staff, environmental consultants and other users. The manuals outline a practical, step-by-step approach to develop, adopt and implement a subwatershed plan. The manuals provide specific guidance on how to identify, design, and construct the watershed restoration practices, describe the range of techniques used to implement each practice, and provide detailed guidance on subwatershed assessment methods to find, evaluate and rank candidate sites.

## *3.2 Stormwater Retrofit Inventory*

Stormwater retrofits are structural stormwater management practices that can be used to address existing stormwater management problems within a watershed. These practices are installed in upland areas to capture and treat stormwater runoff before it is delivered to the storm drainage system, and ultimately, the Wicomico River. They are an essential element of a holistic watershed restoration program because they can help improve water quality, increase groundwater recharge, provide channel protection, and control overbank flooding. Without using stormwater retrofits to address existing problems and to help establish a stable, predictable hydrologic regime by regulating the volume, duration, frequency, and rate of stormwater runoff, the success of many other watershed restoration strategies -- such as stream stabilization, reduced erosion, and aquatic habitat enhancement -- will be threatened. In addition to the stormwater management benefits they offer, stormwater retrofits can be used as demonstration projects, forming visual centerpieces that can be used to help educate residents and build additional interest in watershed restoration.

### *Assessment Protocol*

Potential stormwater retrofit opportunities at a number of candidate project sites in the South Prong subwatershed were assessed during the retrofit inventory. A Retrofit Reconnaissance Inventory (RRI) field form was used to evaluate retrofit opportunities at candidate sites. Field crews look specifically at drainage patterns, the amount of impervious cover, available space, and other site constraints when developing concepts for a site. Candidate retrofit sites identified for the assessment generally had one or more of the following characteristics:

- Situated on publicly-owned or publically-operated lands or open spaces (e.g. school sites, parks)
- Located on commercial and industrial sites with large areas of impervious cover
- Could serve as a demonstration project; and
- Located at existing stormwater management facilities

It should be noted that the pre-identified sites represent only a portion of the potential retrofit opportunities in the subwatershed. A more thorough search will likely yield more retrofit opportunities.

*Water Quality and Pollutant Removal Calculations*

A water quality volume (WQv), or the storage needed to capture and treat the runoff volume for 90% of the average annual rainfall, was calculated for each retrofit drainage area. This volume captures high pollutant loads in the "first-flush" of stormwater runoff from all rainfall events. The WQv was calculated for each proposed retrofit as follows:

$$WQ_v = [(P)(R_v)(A)] / 12$$

Where $WQ_v$ = water quality volume (acre-feet)
P = design storm runoff depth (1 inch)
$R_v = 0.05 + 0.009(I)$, where (I) is the percent impervious cover of the site
A = site drainage area (acres)

This volume reflects the water quality design volume defined in Chapter 2 of the Maryland Stormwater Design Manual (MDE, 2009), and is used to assess each retrofit's sizing and pollutant removal potential.

Nutrient load reductions for nitrogen, phosphorus, and total suspended solids (TSS), were calculated based upon several factors:

- The expected nutrient loading to the practice, which is derived from event mean concentrations (EMCs) for nitrogen (2.0 mg/L), phosphorus (0.27 mg/L), and total suspended solids (59 mg/L) (Schueler, et al. 2007)
- Estimated pollutant removal percentages for full-sized practices (designed to treat the WQv) (Hirschman, et al. 2008)
- Adjustments to the pollutant removal percentages based upon the % of the WQv that a proposed retrofit treats. (An undersized practice will treat less of the annual rainfall, and therefore provide a smaller nutrient load reduction. However, the relationship is not linear due to rainfall variability; smaller rain events happen more frequently, so even "undersized" practices can treat a significant portion of annual rainfall.)

For the North Prong Subwatershed nutrient and sediment reduction estimates, the Center used "Recommendations of the Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects" method (http://chesapeakestormwater.net/wp-content/uploads/downloads/2012/10/Final-CBP-Approved-Expert-Panel-Report-on-Stormwater-Retrofits-short.pdf). This new method uses curves to estimate the benefit of a practice given the amount of water treated from the contributing drainage area. Curves representing total nitrogen (TN), total phosphorus (TP), and total suspended sediment (TSS) are available. All stormwater management practices are placed into either the "runoff reduction" (RR) or "stormwater treatment" (ST) category, which is used to determine the specific efficiency curve.

*Cost Estimates*

Planning level cost estimates were developed for each proposed retrofit. The per cubic foot cost estimates for each type of practice were adapted mainly from *Costs of Stormwater Management Practices in Maryland Counties* (King and Hagan, 2011), although information from CWP's *Urban Stormwater Retrofit Practices Manual* (Schueler et al. 2007) and professional judgment were utilized as well to refine the estimates for certain proposed retrofits.

For the North Prong Subwatershed project cost estimates, more emphasis is placed on the King and Hagan (2011) publication. Some work was done to extrapolate published cost values to express them per unit of water treated by assuming the stormwater management practices in King and Hagan (2011) treated 1 inch of runoff.

### *3.3 Unified Subwatershed and Site Reconnaissance*

The Center conducted the Unified Subwatershed and Site Reconnaissance (USSR) to evaluate pollution-producing behaviors and restoration potential in upland areas of the subwatersheds. The USSR is a "windshield survey" where field crews drive watershed roads to determine specific pollution sources and identify areas outside the stream corridor where pollution prevention possibilities exist. The USSR can be a powerful tool in shaping initial subwatershed restoration strategies and locating potential stormwater retrofit or restoration opportunities. The goal of the USSR is to quickly identify source areas that are contributing pollutants to the stream, and reduce these pollutant loads through source controls, outreach and change in current practice, and improved municipal maintenance operations. Additional information on the USSR is found in Wright et al. (2005).

#### *3.3.1 Hotspot Investigations*

Pollution source control includes the management of potential "hotspots" which are certain commercial, industrial, institutional, municipal, and transport-related operations in the watershed. These hotspots tend to produce higher concentrations of polluted stormwater runoff than other land uses and also have a higher risk for spills. They include auto repair shops, department of public works yards, restaurants, etc. Specific on-site operations and maintenance combined with pollution prevention practices can significantly reduce the occurrence of "hotspot" pollution problems. After evaluating each hotspot site for pollution producing problems, each site was evaluated for retrofit opportunities as indicated above under the retrofit reconnaissance inventory.

*Assessment Protocol*

The Hotspot Site Investigation (HSI) is used to evaluate commercial, industrial, municipal or transport-related sites that have a high potential to contribute contaminated runoff to the storm drain system or directly to receiving waters. At hotspot sites, field crews look specifically at vehicle operations, outdoor materials storage, waste management, building conditions, turf and landscaping, and stormwater infrastructure to evaluate potential pollution sources (Table 3. 1). Based on observations at the site, field crews may recommend enforcement measures, follow-up inspections, illicit discharge investigations, retrofits, or pollution prevention control and education.

The overall pollution prevention potential for each hotspot site is assessed based on observed sources of pollution and the potential of the site to generate pollutants that would likely enter the storm drain network. A hotspot designation criterion set forth in Wright et al. (2005) was used to determine the status of each site based on field crew observations. Sites are classified into four initial hotspot status categories:

- Not a hotspot – no observed pollutant; few to no potential sources
- Potential hotspot – no observed pollution; some potential sources present
- Confirmed hotspot – pollution observed; many potential sources
- Severe hotspot – multiple polluting activities directly observed

**Table 3. 1. Potential Hotspot Pollution Sources**

| Type | Description | Examples |
|---|---|---|
| Vehicle Operations | Routine vehicle maintenance and storage practices, as well as vehicle fueling and washing operations | • Vehicle storage and repair<br>• Fueling areas<br>• Vehicle washing practices |
| Outdoor Materials | Exposure of outdoor materials stored at the site | • Loading and unloading<br>• Outdoor materials<br>• Secondary containment |
| Waste Management | Housekeeping practices for waste materials generated at the site | • Dumpster practices |
| Stormwater Infrastructure | Practices used to convey or treat stormwater, including the curb and gutter, catch basins, and any stormwater treatment practices | • Catch basins<br>• Stormwater treatment practices |

### *3.3.2 Neighborhood Source Assessment*

Residents engage in behaviors and activities that can influence water quality. Some behaviors that negatively influence water quality include over-fertilizing lawns, using excessive amounts of pesticides, and poor housekeeping practices such as inappropriate trash disposal or storage. Alternatively, positive behaviors such as tree planting and using native plants, disconnecting rooftops, and picking up pet waste can help improve water quality.

#### *Assessment Protocol*

The Neighborhood Source Assessment (NSA) was conducted to evaluate pollution source areas, stewardship behaviors, and restoration opportunities within individual residential areas. The assessments focus specifically on yards and lawns, rooftops, driveways and sidewalks, curbs, and common areas. Table 3. 2 provides examples of the types of restoration opportunities that were evaluated for each site.

An NSA field form was used to assess neighborhoods in terms of age, lot size, tree cover, drainage, lawn size, general upkeep, evidence of pollution sources, and evidence of resident stewardship (i.e., storm drain stenciling, pet waste management signage, etc.). Each site was assigned a pollution severity rating of “severe,” “high,” “moderate,” or “low,” using a set of benchmarks set forth in Wright et al. (2005). Pollution severity is an index of the amount of non-point source pollution a neighborhood is likely generating based on easily observable features (i.e., lawn care practices, drainage patterns, oil stains, etc.). A restoration potential rating of "high," "moderate," or "low" was also assigned to each neighborhood. Restoration potential is a measure of how feasible onsite retrofits or behavior changes would be based on space, number of opportunities, presence of a strong homeowner association (HOA), and other similar factors.

**Table 3. 2. Types of Projects Identified during Neighborhood Source Assessment**

| Type | Description | Examples |
|---|---|---|
| On-site Retrofits | Homeowners reduce stormwater runoff generated by their lots | • Rain gardens<br>• Rain barrels<br>• Other rooftop disconnection |
| Lawn and Landscaping Practices | Better lawn and landscaping practices minimize the use of chemicals and encourage the use of native landscaping, particularly in neighborhoods where high input lawns and extensive turf cover are prevalent | • Improved buffer protection<br>• Native plantings<br>• Turf reduction<br>• Proper fertilizer and pesticide application<br>• Ditch restoration |
| Open Space Management | Management of neighborhood common areas or courtyards | • Landscaping<br>• Tree planting<br>• Pet waste education<br>• Stream buffer restoration<br>• Trash removal |
| Education and Outreach | Providing homeowners with additional information to better manage pollution in their residential lots | • Lawn and nutrient management outreach<br>• Rain barrel and rain garden education<br>• Septic system education<br>• Storm drain stenciling |

### *3.4 Unified Stream Assessment*

#### *Assessment Protocol*

The primary assessment protocol used to assess stream corridors in the South Prong subwatershed was the Unified Stream Assessment (USA), which is a comprehensive stream walk protocol developed by the Center for evaluating the physical riparian and floodplain conditions in small urban watersheds. The USA integrates qualitative and quantitative components of various stream survey and habitat assessment methods and is used to identify locations of severely eroded stream banks, utility crossings, stormwater outfalls, impacted riparian buffers, excessive trash accumulation and dumping, stream crossings, and channel modifications within the stream corridor. Restoration opportunities for discharge prevention, stream restoration, stormwater retrofits, and riparian reforestation are also identified. More detail on conducting the USA protocol can be obtained directly from Kitchell and Schueler (2004).

### *3.5 Identification of Protection Opportunities*

The second goal for the Wicomico Watershed as identified by the Core Team and stakeholders is to "Protect existing resources, particularly green infrastructure, ecologically significant areas, farmland, and drinking water supplies" via the following objectives: 1) Promote the use of agricultural BMPs; 2) Increase existing tree canopy; and 3) Protect existing wetlands and natural areas. Objective 1, promote the use of agricultural BMPs, has not been specifically addressed in this watershed plan as this objective is primarily being met through activities associated with the Natural Resources Conservation Service and Wicomico Soil Conservation District. The local District Conservationist can be contacted for additional information regarding agricultural BMPs in the subwatersheds: http://www.mascd.net/WicomicoSCD/index.html. Objective 2, increase existing tree canopy has been addressed through restoration projects identified above that promote buffer restoration in the riparian corridor and tree planting in upland areas. This section of the watershed plan primarily addresses objective 3; protect existing wetlands and natural areas.

Protection opportunities in the subwatersheds have been prioritized based on a desktop assessment, which was corroborated in part by the field-based stream assessment conducted for the development of this action plan. The USA identified several excellent stream reaches that were primarily associated with streams that had large (>100') riparian buffers. These areas have excellent in-stream and riparian habitat. To prevent further degradation of the subwatershed and downstream water quality, it is important that these areas remain protected from development and urban/suburban encroachment. Opportunities to protect land from development are available through the State and County. The Lower Shore Land Trust (LSLT) (http://www.lowershorelandtrust.org/pages/home.php) specializes in assisting landowners with identifying the most appropriate means for protecting properties and can be contacted for information regarding protection opportunities in the watershed.

Three GIS layers were used to identify priority areas for protection in the subwatershed. These layers are shown in Table . Using these layers, high priority areas were identified for protection.

**Table 3.3. GIS Layers used to Identify Protection Priorities in the South Prong Subwatershed**

| GIS Layer | Source | Description | Rationale |
|---|---|---|---|
| Sensitive Species | Maryland Department of Natural Resources | The statewide vector file shows buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types. It was created over USGS 7.5 minute topographic quadrangle maps and it generally includes, but does not specifically delineate, such regulated areas as Natural Heritage Areas, Wetlands of Special State Concern, Colonial Waterbird Colonies, and Habitat Protection Areas. | Habitat that supports rare, threatened and endangered (RTE) species should be prioritized for protection. |
| Bionet | Maryland Department of Natural Resources | A biodiversity conservation network that identifies and prioritizes ecologically important lands to conserve Maryland's biodiversity (i.e., plants, animals, habitats, and landscapes). This dataset aggregates | These areas have been pre-identified by the state as important ecological areas and should be prioritized for protection. |

| | | | |
|---|---|---|---|
| | | numerous separate data layers hierarchically according to the BioNet Criteria Matrix. | |
| Protected Land | Maryland Department of Natural Resources | A CWP file that merges MD DNR datasets for agricultural land preservation foundation easements, protected County lands, DNR lands and conservation easements, forest conservation easements and private conservation easements | Sensitive species habitat or important ecological areas adjacent to already protected land should be prioritized for protection to promote habitat connectivity and provide for larger green infrastructure hubs and corridors. |

# SECTION 4. FINDINGS

## *4.1 Subwatershed Assessment General Findings*

### *4.1.1 Nomenclature*

A key to the nomenclature used by field teams during the assessment work is provided in Table 4. . The naming convention was designed to be flexible for multiple field teams and to immediately impart key information about the site. Identifiers consist of three parts: 1) the abbreviation of the subwatershed in which the site or reach is located, in this case “SP” for South Prong, “TT” for Tony Tank and “NP” for North Prong; 2) the type of assessment conducted, and 3) a unique identifier that is employed as a team evaluates a site, reach or project. This nomenclature was carried through the project and is used elsewhere in this *Plan*.

**Table 4. 1. Site Naming Nomenclature**

| Assessment Type | Abbreviation |
|---|---|
| Retrofit | RRI |
| Hotspot | HSI |
| Neighborhood | NSA |
| Stream Reach | RCH |
| Outfall | OT |
| Stream Crossing | SC |
| Trash and Debris | TR |
| Impacted Buffer | IB |
| Eroded Bank | ER |
| Channel Modification | CM |
| Miscellaneous | MI |

A summary of general observations made by field crews during the stream and upland assessments of the South Prong, Tony Tank and North Prong subwatersheds are discussed in Section 4.1.2. The locations of assessed sites are shown in Appendices B-D and a list of all the sites and identified projects are listed in Appendices E-G.

After the field assessments were completed, a ranking system was developed to prioritize identified management and restoration practices within each practice group. Using best professional judgment, each practice location was assigned points and ranked according to the factors listed below:

- *Cost* – The cost associated with project implementation. Project costs represent only planning level estimates and were determined based on guidance provided in Schueler et al. (2007), Wright et al. (2005), Kitchell and Schueler (2004) and King and Hagan, 2011.
- *Community Education and Involvement* – Project with potential to educate and involve the community .
- *Visibility* – Projects with high visibility and potential to raise the public’s awareness of the watershed (visible from street or located in public park).

- *Feasibility* – Project with high potential that it will be implemented. The site has access for equipment, low maintenance burden, serves as a demonstration site and is publicly owned.
- *Water Quality Improvement* – Potential for treatment or prevention of pollutants. Treats water quality volume or eliminates exposure of pollutants to stormwater runoff. Additional points awarded for projects located in the watershed headwaters.
- *Ecological Benefit* – Project provides an ecological, habitat, or natural resource protection benefit.
- *Protection Priority* – Project is located in a high priority or priority protection area (see Section 4.1.5 of this report).
- *Meeting Watershed Objectives* – Potential for project to assist in achieving watershed objectives (see the Watershed Plan Executive Summary).

The ranking system was based on 120 points. The ranking factors and criteria are described in more detail in Appendix H. A list of all the sites visited along with their ranked priority and planning level cost estimates is included in Appendices E-G. The estimated costs are preliminary and should be used to guide the watershed stakeholders. These estimates should be adapted to include more appropriate local cost estimates where available. Additional information on project costs can be found in Section 5.

### *4.1.2 General Findings*

The following are general findings from the field assessments that field crews encountered throughout the South Prong, Tony Tank and North Prong subwatersheds.

*Stormwater Retrofit Assessment General Findings*

<u>1. Sandy soils</u>
Sandy soils with high infiltration rates appear to make up much of the subwatershed, which makes infiltration-based retrofits a viable option in many locations (if there is suitable depth between surface and groundwater elevation). Infiltration retrofits can be implemented in many locations that are unsuitable for other practices (such as filters or bioretention), as there is no need to connect an underdrain to the storm sewer system. Less infrastructure installation makes infiltration-based practices less costly as well. A basic infiltration test should be part of the next stage of design for most of the practices identified, in order to determine if infiltration will be feasible.

<u>2. High water table</u>
It appears that in some parts of the subwatershed, the water table is very shallow – two feet or less below existing grade. Several types of retrofit practices (infiltration, filters, bioretention, etc.) require several feet of depth, and are therefore inappropriate in high water table conditions. Water table elevations should be checked for sites that proceed to the next stage of design to ensure the proposed practices’ feasibility.

3. Existing wet ponds

Several sites inspected as a part of the reconnaissance inventory included existing wet ponds. While some of these wet ponds included an outlet structure that maintains a permanent pool while providing detention capacity for large storms, many did not. These other wet ponds generally had a single weir overflow that directs water to a road ditch or other structure (Figure 4. 1). These types of wet ponds provide less treatment during storm events, and may be difficult to retrofit effectively. It appeared that the outlet structures (usually overflow weirs) did not provide any significant restriction of flow, especially for smaller storm events, such as the 2-year storm. If the ponds are not providing detention of storm events, they still have a water quality benefit, but not as much as if detention were provided.

**Figure 4. 1. Wet pond with weir outlet structure to road ditch**

4. Municipal parking lots

Several municipal parking lots near downtown Salisbury are apparently slated for re-development. In their current state, almost all of these parking lots have some opportunity for stormwater retrofits. If the sites are re-developed, the proposed retrofits may no longer be appropriate. However, redevelopment of these sites would require the implementation of stormwater management practices in accordance with Chapter 5 of the Maryland Stormwater Design Manual, which will lead to an improvement in runoff quality from these sites.

5. Lack of stormwater treatment

Throughout the watershed, a lack of stormwater treatment was observed for many development sites. At many of these sites, untreated stormwater discharges directly to wetlands, stream channels, or the stormdrain system. Unmanaged stormwater can contribute high pollutant loads to the receiving waterbodies, and can also result in high stormwater runoff flow rates that cause streambank erosion and degrade stream habitat.

6. Schools and Parks

Some of the schools and parks visited during field work had no stormwater management practices. In addition, there were often large areas of turf grass or bare soils with very little or no trees. Opportunities were often present to disconnect downspouts to discharge runoff across grassy areas or to treat rooftop runoff in a rain garden or bioretention system (Figure 4. 2).

Schools and parks are great places for stormwater retrofits because of the educational and demonstration component associated with projects. An understanding of stormwater and the environment can be incorporated into school science curriculums. Students can learn about the connection between stormwater, Wicomico River, and how they can play a part in improving water quality. Additionally, these sites can serve as good community demonstration projects.

**Figure 4. 2. Rain garden opportunity at Prince Street School**

*Neighborhood Source Assessment General Findings*

1. Lawn and Landscaping Practices

Generally, the single family neighborhoods had high amounts of grass but were not highly managed. High amounts of fertilization were noted in the common areas and lawns of some single family neighborhoods, however, evidence of high fertilization was found mainly in the multifamily neighborhoods. High fertilization was evidenced by highly manicured lawns that were very green. Buffers could be added to lawns that lead directly to the stream or ponds. Also, in several neighborhoods, particularly newer ones, a lack of tree canopy was observed.

2. Pollution Prevention Practices

No stormdrain inlet marking or stenciling was observed in the neighborhoods. Several neighborhoods had evidence of organic matter and some trash since in nearby streams. Organic matter and sediment was observed in the street and storm drain network. The following efforts could reduce pollution sources from organic matter and sediment: 1) homeowner education to remove tree and lawn debris from roadways that then enter storm drains; 2) leaf pick up or more frequent leaf pick up program; and/or 3) street sweeping. Finally, some neighborhoods were determined to use sewer however some neighborhoods use septic systems and outreach and education to these neighborhoods, particularly those around lake/pond systems, should be conducted.

3. Residential Retrofit Opportunities

Many neighborhoods were observed to have little or poorly functioning stormwater management practices that treat water quality (many practices were observed that treat water quantity). Onsite retrofits included rain barrels and rain gardens in the neighborhoods to improve stormwater quality, provide lawn landscaping opportunities, and utilize rainwater harvesting. Rain gardens may not be as useful as rain barrels due to the available space and gentle slopes (i.e., low hydraulic head). Evidence of goose waste near stormwater ponds indicates excess bacteria entering the receiving waters. Several opportunities for improved stormwater management noted include the following: 1) bioretention or other stormwater management in street conveyance channels; 2) bioretention or other stormwater management for stormwater pond pretreatment; 3) neighborhood stormwater pond water quality retrofits; 4) stormwater pond general maintenance and/or repair; 5) stormwater treatment incorporation into wide residential roadways and 6) ditch restoration (Figure 4.3). Additionally, many specific retrofit projects were identified in the neighborhoods.

**Figure 4. 3. Opportunity for ditch restoration in SP_NSA_6.**

*Hotspot Site Investigation General Findings*

1. Municipal Facilities

Municipal facilities were points of concern for vehicle maintenance, storage and repair; outdoor storage; and waste management. Implementation of pollution prevention and good housekeeping procedures on these sites is needed to address water quality concerns and also because these sites represent demonstration opportunities and an important part of a community's overall stormwater education and outreach program.

2. Storage of outdoor materials and waste management

Outdoor materials, including 55 gallon drums and grease barrels, noted at gas stations and restaurants without secondary containment and lids not secure. Dumpsters were found to be leaking with bulk trash dumped and/or spilling outside of the dumpster and some locations had illegal dumping occurring on the premises. Restaurant grease storage containers were found to be leaking and with significant stains all around at several locations. Chesapeake Shipbuilding, a severe hotspot with multiple concerns is located in the critical area and further action, as described below is recommended.

3. Vehicle Activities

Washing of vehicles at commercial facilities was noted at several locations. This activity was found to occur on impervious cover without any treatment for the washwater. Gas pumps without cover were noted at other sites. Municipal facilities store, maintain and fuel vehicles and additional pollution control is warranted.

4. Turf/Landscaping Areas

A Salisbury Zoo exhibit for 21 animals has direct interaction with the water. This includes a number of mammals and large birds. Other wildfowl tend to flock with the zoo exhibit animals.

*Stream Assessment General Findings*

1. Stream Buffer Encroachment
Buffer encroachment from urban and suburban land uses is a primary impairment to streams throughout the subwatersheds. Larger, forested stream buffers were noted in many locations and streams were generally in much better condition in these areas. Stream buffer impacts were noted associated with residential homeowner encroachment on the stream as well as from urban land use in the downtown section of Salisbury. A total length of 54,972 linear feet of the stream corridor was recorded as having an impacted buffer.

2. Channel Modification
The streams have been extensively modified, armored and channelized in many reaches of the lower subwatershed as well as in some upper reaches. In some of these cases, concrete channels can be restored to a more natural channel to provide infiltration and nutrient processing and armoring can be removed and replaced with living shorelines. Stream in the headwaters have been modified as drainage ditches and can be enhanced with wider buffers and pollutant management strategies for trash, sediment and nutrients.

3. Illicit Discharges
Several pipes were noted as having dry weather flow or other indicators of potential illicit discharges. These pipes should be sampled for potential illicit discharges as indicated in a report compiled by CWP (2011) to the City of Salisbury.

4. Dams
At least 12 dams were noted throughout the three subwatersheds. Eutrophication is problematic within the impoundments, most likely from phosphorus loading, from failing septics, geese and stormwater runoff. The ponds are typically dominated by aquatic weeds due to shallow depths. The weeds are likely difficult to control because they get their nutrients from the sediment (past loads) rather than the water column (current loads).

### *4.1.3 Lakes and Ponds*

Regarding the lakes in South Prong, Tony Tank and North Prong Subwatersheds, managers should study the ecological factors that sustain and reinforce dense populations of aquatic weeds. Lake managers may need to resort to in-lake treatment practices such as harvesting, dredging, water level manipulations or applications of herbicides. These practices often need to be combined with emerging “biomanipulation” practices, and the more traditional watershed treatment practices that can reduce phosphorus inputs to lake sediments (Schueler and Simpson, 2001). Better site design and implementation of stormwater treatment practices will also reduce phosphorus loading (see Figure 4. 4).

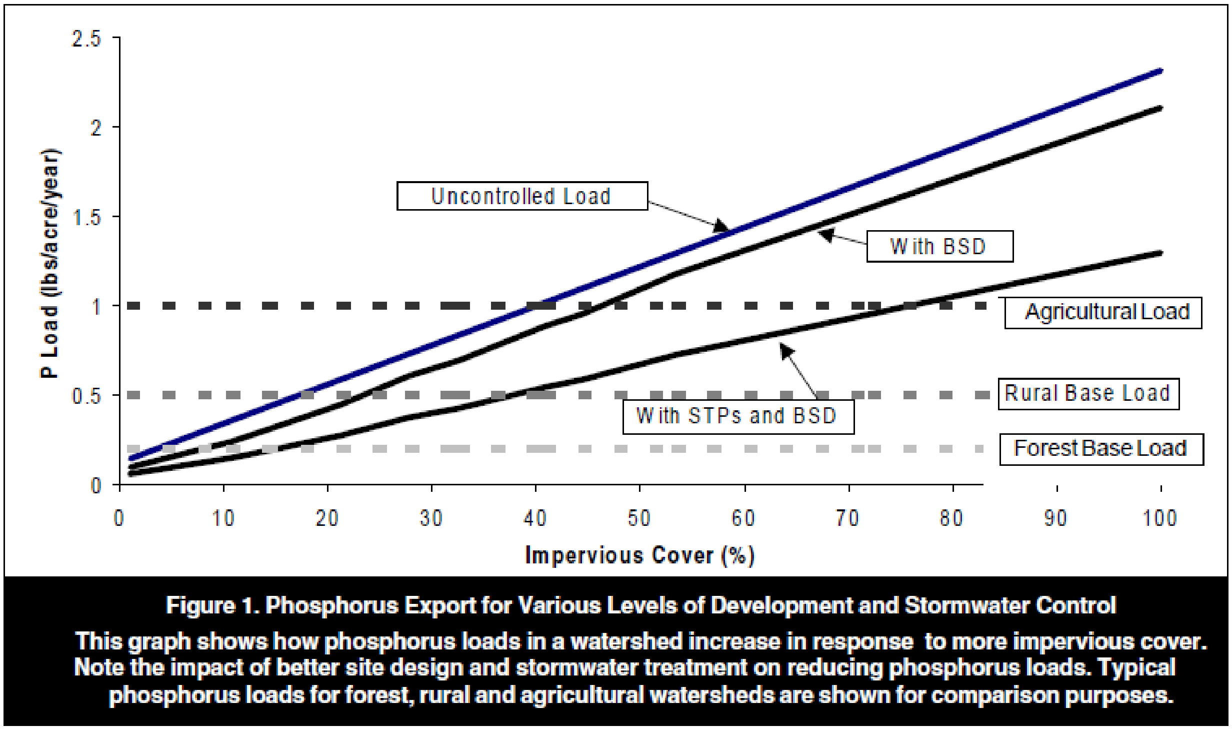



**Figure 4. 4. Better site design and stormwater treatment reduce phosphorus loading (Caraco, 2001)**

Some general treatment options for the restoration of urban lakes are presented below.

1) Alum Treatment – This is used to precipitate phosphorus in the water column. It can be good in locations where external phosphorus loading has been controlled and is more suited for algae infested lakes (i.e., to treat phosphorus in the water column).
2) Dredging – Dredging removes bottom sediments (and accumulated toxics) but can be problematic in terms of finding a site for disposal of the dredge spoils. If this technique is pursued, the lake should be tested ahead of time for toxics.
3) Weed Harvesting – Mechanical harvesting of weeds can be successful and there is an advantage in being able to control the size of the treatment area. However, harvesting may spur rapid regrowth of some plants, the initial purchase of equipment can be high, and harvesting may be required at least annually.
4) Hypolimnetic Withdrawal – This technique removes nutrient rich waters at the bottom of the lake. The objectives are to: 1) eliminate mixing of nutrient-rich bottom layers with the epliminion and 2) reduce residence time of water in the hypoliminion, thereby reducing opportunities for anaerobic conditions to form. This technique only works for lakes that are thermally stratified. Consideration should be given to the fact that nutrient laden waters will be discharged downstream unless it is discharged to a constructed wetland for treatment. In addition, this technique could trigger algal blooms.
5) Circulation / Aeration – This refers to circulating lake water to limit algal biomass by limiting light penetration. In lakes where iron binds phosphorus, the increased dissolved oxygen levels can decrease internal phosphorus loads generated by sediment release during anoxia. In lakes where calcium controls phosphorus, the internal loading may increase from circulation. This technique may not work at all in shallow, unstratified lakes.

6) Drawdown – This technique exposes plant roots to drying and / or freezing that can damage roots / seeds. The effects are species dependent and some species may thrive after drawdown. Drawdown can be used to remove sediment, install sediment covers and make repairs. In addition, it can be used to install fish habitat structures in the littoral zone as well as to manage fish populations.
7) Sediment Covers – These are installed flush on lake bottom and securely anchored to prevent aquatic weed growth. Sediment covers may be costly and are usually reserved for small areas around docks and swimming areas. They need to be maintained by removing sediment that accumulates on top.
8) Biological Controls – These are used to control weeds and could include grass carp or insects. Managers need to make sure that the controls go for the target plant and be aware that overstocking can dramatically change the fish community structure. In addition, totally eradicating the aquatic weeds can create an algal dominated lake.
9) Biomanipulation – This technique reduces fish species that consume zooplankton to enhance algal grazing by zooplankton thereby improving water clarity. The technique can be used in shallow lakes. An example of this technique would be to eliminate the existing fish community with rotenone and then restocking with largemouth bass or walleye that consume planktivores.

### *4.1.4 Tree Planting Opportunities*

Tree planting opportunities were identified during the stormwater retrofit assessment, neighborhood assessment and stream assessment. These opportunities are called out specifically because tree planting is a very cost effective restoration action that provides multiple benefits, including ecological, economic and quality of life benefits – protecting air and water quality, reducing energy costs, increasing property values and beautifying neighborhoods and highways. Altogether, 327.4acres of tree planting opportunities were identified in the subwatersheds. Table 4. provide a breakdown of the different types of tree planting opportunities that were identified. A map of their locations is provided in Appendices B and C and a list of sites is provided in Appendices D and E. It should be noted these opportunities should be field verified before any planting begins. In addition, landowners should be consulted and a local forester engaged to discuss tree planting density, species selection and site constraints.

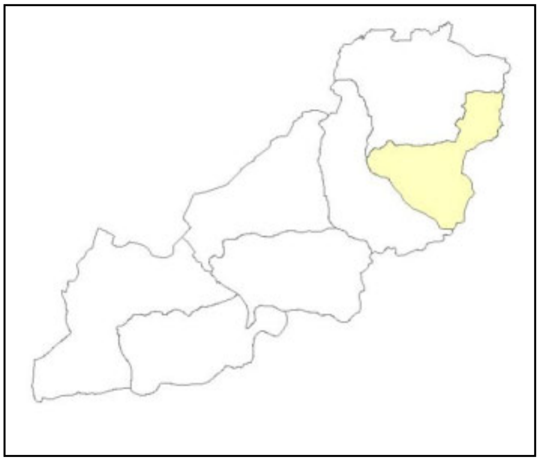
**Table 4. 2. Tree planting opportunities (acres)**

| | **Impacted Buffers** | **Institutional** | **Neighborhood Common Areas** | **Neighborhoods Individual Lots** | ***Totals*** |
|---|---|---|---|---|---|
| South Prong | 14.8 | 15.6 | 10.1 | 0.0[3] | *40.5* |
| Tony Tank | 15.5 | 12.6 | 36.8 | 69.2 | *134.1* |
| North Prong | 6.4 | 0.0[4] | 146.4 | 0.0[5] | *152.8* |
| **Total** | **36.7** | **28.2** | **193.3** | **69.2** | ***327.4*** |

[3] Common area vs individual lot tree planting opportunities were not differentiated during the South Prong Assessment.
[4] Institutions were not assessed during the North Prong Assessment.
[5] Common area vs individual lot tree planting opportunities were not differentiated during the North Prong Assessment.

## 4.2 South Prong Subwatershed Findings

### *4.2.1 South Prong Overview*



| **Table 4. 3. South Prong Subwatershed Characteristics** | | |
|---|---|---|
| Drainage Area | | 14,816 acres |
| Existing Impervious Cover | | 1,665 acres (11.2%) |
| Stream Miles | | 32.82 miles |
| 2006 Land Use | Developed, Open Space | 13.7% |
| | Developed, Low Intensity | 9.8% |
| | Developed, Medium Intensity | 5.6% |
| | Developed, High Intensity | 3.4% |
| | Forest / Shrub | 18.5% |
| | Cropland and Pasture | 30.8% |
| | Woody & Herbaceous Wetlands | 17.0% |
| Jurisdictions as Percent of South Prong | | 16.8% Salisbury<br>83.2% Wicomico County |

The South Prong subwatershed is located in the northeast part of the Wicomico Watershed. It has been classified as an Impacted Urban subwatershed for the Wicomico (see the Characterization Report in Section 2). Nearly 17% of the subwatershed falls within the City with the remaining 83.2% is contained within Wicomico County (Table 4. ). Land use is a mixture of developed (32.5% for all intensities) and cropland / pasture (30.8%). Forest cover (deciduous, evergreen, mixed and shrub/scrub) makes up an additional 18.5% and wetlands (woody and emergent herbaceous) cover 17% of the subwatershed. Soils are primarily in hydrologic soil groups D (high runoff potential, very slow infiltration) and C (moderately high runoff potential, slow infiltration) (Table 4. ). Hydrologic group A soils have low runoff potential and high infiltration rates and B soils have moderately low runoff potential and moderate infiltration rates. Figure 4. 5 shows the distribution of soils across the subwatershed. D soils are found in the impervious downtown area, along the river valleys and in the northern arm of the subwatershed.

| **Table 4. 4. Soils in the South Prong Subwatershed** | |
|---|---|
| **Hydrologic Soil Group** | **Acres (%)** |
| A | 3,023 (20.4%) |
| B | 2,286 (15.4%) |
| C | 3,758 (25.4%) |
| D | 5,574 (37.6%) |

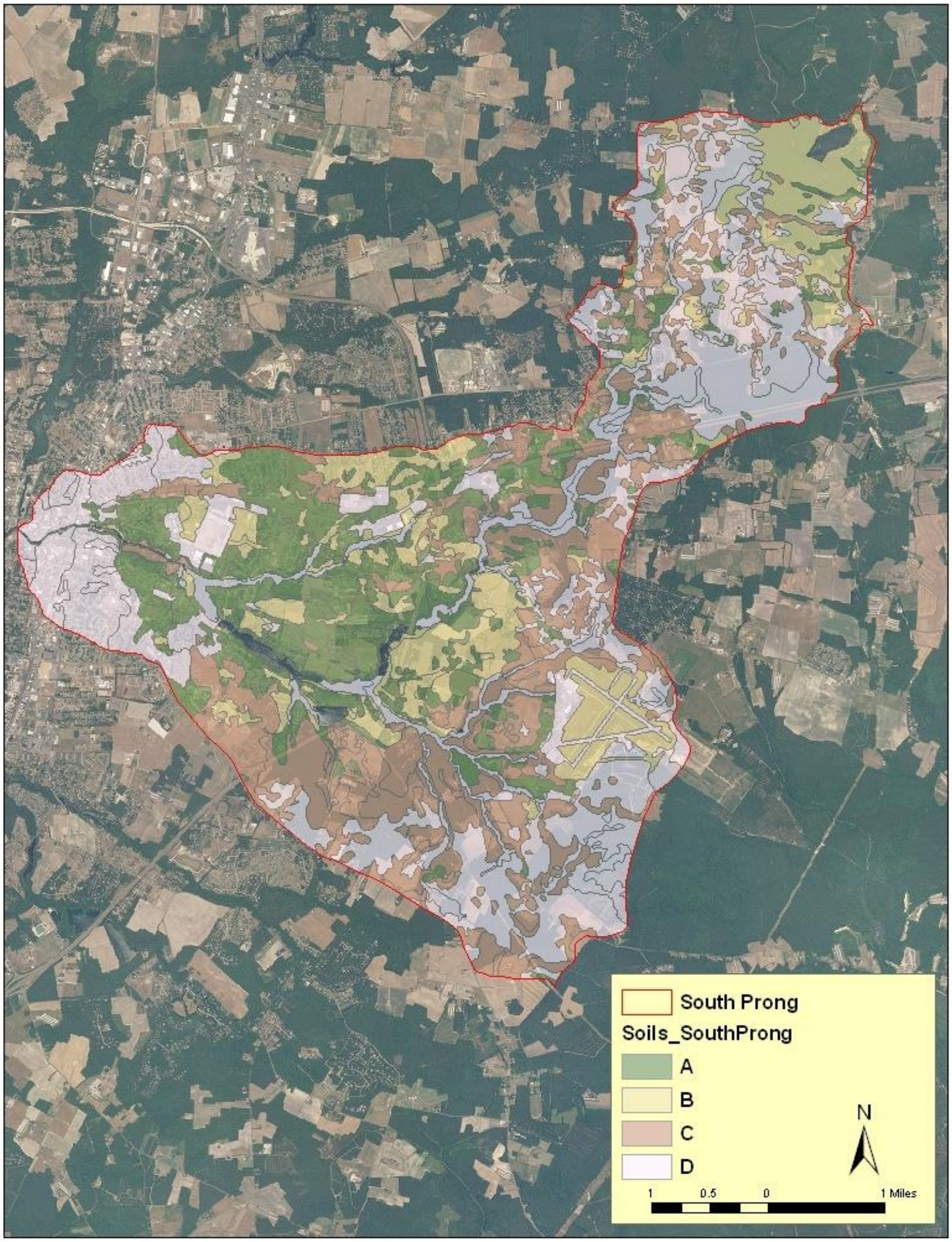



**Figure 4. 5. Soil distribution across the South Prong subwatershed**

*4.2.2 South Prong Field Assessment and Findings*

In June, 2012, field work was conducted in the 23.15 square mile South Prong subwatershed of the Wicomico River. The watershed field assessment strategy aimed to meet initial watershed restoration and protection goals outlined by the watershed planning Core Team and watershed stakeholders. These general watershed goals were to:

- Improve water quality;
- Protect existing resources; and
- Restore watershed function

During these field assessments, the field crew teams, consisting of one Center staff and volunteers from the Wicomico Environmental Trust, Wicomico County, and other interested individuals, visited over 184 locations in the watershed and used one of four field assessment methodologies to evaluate the feasibility of implementing a management or restoration practice. Approximately 46 potential stormwater retrofit sites, 21 potential hotspot locations, 23 residential neighborhoods, and 8.4 miles of stream (22 stream reaches) were assessed in the South Prong subwatershed. Table 4. provides a summary of general findings from the field assessments.

**Table 4. 5. General Findings from South Prong Field Assessments**

| Task | General Findings |
|---|---|
| Stormwater Retrofit Inventory | • 46 sites visited<br>• 67 potential stormwater retrofits identified for 39 sites<br>• Focus on water quality treatment<br>• Identified 6 high priority projects and 48 medium priority projects<br>• Types of retrofits include bioretention areas, infiltration, constructed wetlands, sand filters, and impervious cover removal |
| Hotspot Site Investigation | • 25 potential hotspot sites investigated<br>• 5 sites identified as potential, confirmed or severe hotspots |
| Neighborhood Source Assessment | • 23 neighborhoods assessed<br>• Pollution severity index: 19 moderate, 4 high<br>• Neighborhood restoration potential: 7 low, 13 moderate and 3 high<br>• Neighborhoods were mix of older and newer single family homes, most without downspouts or disconnected<br>• Types of recommendations include rain barrels, demonstration rain gardens, free community trainings, storm drain stenciling, tree planting, buffer management, and nutrient/lawn homeowner management outreach |
| Unified Stream Assessment | • Walked 8.4 miles of stream<br>• Assessed 22 stream reaches and impacts to 2 ponds<br>• Completed site impact evaluations at 6 stream crossings, 7 modified channels, 1 erosion site, 18 outfalls, 13 impacted buffers, 1 trash site, 3 dams and 1 miscellaneous impact<br>• Identified 20 project, including 7 high priority riparian corridor projects<br>• Major findings include reaches with abundant trash in lower reaches, many dry channels in the headwaters, areas of excellent habitat and intact buffers in the upper reaches, poor stream buffers in the lower reaches, several channel modifications, and invasive Japanese knotweed noted throughout the watershed |

*Stormwater Retrofit Inventory*

A total of 46 stormwater retrofit sites were visited by field crews throughout the South Prong subwatershed and a total of 67 preliminary retrofit concepts were developed at 39 of the sites (Appendix E). Multiple concepts were developed for several of the sites and are indicated by a letter after the site number (i.e., SP-RRI-19B). There were no concepts developed for 7 sites that either had adequate stormwater management or significant site constraints such as access or feasibility. A map of the RRI sites visited is found in Appendix B.

The majority of stormwater retrofit opportunities identified in the watershed were on publicly-owned land in highly visible locations, such as public schools, parks, and municipal parking lots. Some retrofit opportunities were identified on privately-owned land, primarily in existing stormwater management facilities or near commercial parking lots. Twelve high priority retrofit projects were identified throughout the subwatershed (Table 4. ). Many opportunities for providing stormwater treatment through bioretention practices were identified at the Parkside High School, Ward Museum, Wicomico Middle School, Prince Street School, public lots in downtown Salisbury and at other parks and public places such as the Salisbury Zoo and Courthouse. One of the highest priority projects identified was a constructed wetland at the Maryland Vehicle Administrative building. For a relatively low cost, this project provides significant water quality improvement benefits with high ecological benefits. The projects identified at schools and parks provide ample opportunity for student and public engagement, education and outreach regarding stormwater management and efforts to improve local water quality. These "living classrooms" established through initial demonstration projects will help to set the stage for successful future implementation. A full list of the retrofit opportunities identified in the South Prong can be found in Appendix E.

**(a)** **(b)** **(c)**

**Figure 4. 6. (a) Bioretention opportunity at SP_RRI_15A; (b) sediment build-up in Ward Museum parking lot (SP_RRI_305A); and (c) existing wet pond at SP_RRI_17 could be retrofit to provide additional water quality treatment**

**Table 4. 6. High Priority Stormwater Retrofit Opportunities in the South Prong**

| Site ID | Location | Retrofit Concept | Drainage Area (ac) | Impervious Cover (%) | % WQv Treated | Cost | TN Removal (lb/yr) | TP Removal (lb/yr) | TSS Removal (lb/yr) | Priority |
|---|---|---|---|---|---|---|---|---|---|---|
| SP_RRI_15A | Parkside High School | Bioretention | 0.32 | 90 | 0.47 | $16,328 | 2.22 | 0.26 | 71.49 | High |
| SP_RRI_15B | Parkside High School | Bioretention | 1.24 | 90 | 0.17 | $22,680 | 4.97 | 0.58 | 160.50 | High |
| SP_RRI_15C1 | Parkside High School | Bioretention | 0.45 | 90 | 0.13 | $6,573 | 1.41 | 0.17 | 48.98 | High |
| SP_RRI_15C2 | Parkside High School | Bioretention | 0.43 | 90 | 0.14 | $6,418 | 1.37 | 0.16 | 47.65 | High |
| SP_RRI_15D1 | Parkside High School | Bioretention | 0.50 | 90 | 0.16 | $8,783 | 1.81 | 0.22 | 62.87 | High |
| SP_RRI_15D2 | Parkside High School | Bioretention | 0.40 | 90 | 0.09 | $4,074 | 0.87 | 0.10 | 30.32 | High |
| SP_RRI_15E | Parkside High School | Bioretention | 4.00 | 25 | 0.17 | $23,573 | 5.16 | 0.60 | 166.45 | High |
| SP_RRI_15F | Parkside High School | Bioretention | 0.30 | 100 | 0.65 | $23,511 | 2.60 | 0.30 | 84.05 | High |
| SP_RRI_17 | MVA | Constructed Wetland | 2.52 | 85 | 0.42 | $21,930 | 6.17 | 1.67 | 364.08 | High |
| SP_RRI_304A | 1008 S Schumaker Woods | Infiltration | 2.00 | 30 | 1.37 | $56,320 | 6.61 | 0.99 | 256.49 | High |
| SP_RRI_305A | Ward Museum of Waterfowl | Infiltration | 1.23 | 100 | 0.38 | $28,529 | 7.66 | 1.14 | 297.32 | High |
| SP_RRI_305B | Ward Museum of Waterfowl | Bioretention | 0.05 | 95 | 0.74 | $4,232 | 0.43 | 0.05 | 13.95 | High |

*Neighborhood Source Assessment*

A total of 23 neighborhoods were visited by the field crews. A list of the assessed neighborhoods can be found in Appendix E. The assessed neighborhoods were predominantly a mix of older and newer single family homes. Older neighborhoods were largely concentrated near the downtown area. There were a few newer developments that were a mix of single family homes and multifamily homes but they were not concentrated geographically in the watershed. Many neighborhoods were observed to have little or poorly functioning stormwater management practices. In addition, few water quality focused BMPs existed in the neighborhoods. A large majority of the homes observed had downspouts that were disconnected to a pervious area.

The South Prong neighborhoods assessed tended to rate as moderate in terms of pollution severity. Four neighborhoods received a rating of high for pollution severity, mostly due to high amount of grass cover in yards and lawns, highly managed turf lawns, evidence of sediment/organic matter in the curb and gutter, and field observed pollution indicators.

Neighborhoods generally rated moderate for restoration potential, with three rating high and seven rating low. Opportunities identified in moderate neighborhoods included rain barrels, rain gardens, tree planting, nutrient and lawn management education and storm drain stenciling. Restoration opportunities in the neighborhoods rated low for restoration potential were limited in opportunity primarily because they were older, smaller, confined lots located near downtown that had little opportunity for targeted restoration campaigns. Downspout disconnection typically offers the best chance to reduce runoff volumes, but most downspouts were disconnected to pervious areas and the low relief (i.e., flat lots) also limited the use of residential rain gardens to capture and treat rooftop runoff. In addition, lawns were not highly managed. The neighborhoods identified as having high restoration potential were multifamily neighborhoods with highly managed turf and low tree cover. In these neighborhoods, projects were identified that included nutrient and lawn management outreach, tree planting, ditch restoration and storm drain stenciling (Figure 4.7). There is an opportunity to engage and reach many residents in these neighborhoods.

Several neighborhoods were identified in the South Prong subwatershed with high priority restoration actions (Table 4. ). Restoration opportunities at these sites include lawn management, tree planting to increase forest canopy, storm drain markers or stenciling, rain barrels and improved management of stormwater ponds. Several neighborhoods were identified as having opportunities for ditch restoration.

**Table 4. 7. Priority Neighborhood Source Control Opportunities in the South Prong Subwatershed**

| Site_ID | Location | Pollution Severity | Restoration Potential | Opportunity | Cost* | Ranking |
|---|---|---|---|---|---|---|
| SP_NSA_15 | South Kaywood Community | Moderate | Low | Rain barrels, storm drain stenciling, homeowner education for lawn and tree management (reduce organics in street & storm drain); RRI-300 Amended Soils in green | $ | High |

**Table 4. 7. Priority Neighborhood Source Control Opportunities in the South Prong Subwatershed**

| Site_ID | Location | Pollution Severity | Restoration Potential | Opportunity | Cost* | Ranking |
|---|---|---|---|---|---|---|
| | | | | space median. | | |
| SP_NSA_21 | New Bedford Way and Long Warf Road | Moderate | Moderate | Homeowner lawn management outreach, back yard buffers for homes adjacent to pond, storm drain stenciling; See RRI-302 pond retrofit. | $ | High |
| SP_NSA_8 | Highland Park | Moderate | Moderate | Tree planting or retrofit for islands with BMP (no retrofit proposed during field visit). | $ | High |
| SP_NSA_9 | Mallard Landing Lakeside | Moderate | High | Tree planting at community park, storm drain stenciling, nutrient & lawn mgt outreach/education. | $ | High |
| SP_NSA_10 | East Lake Subdivision | High | Moderate | Nutrient management outreach, septic education, buffer at Riden Court, better management for pond trail at Riden Court. | $ | High |
| SP_NSA_14 | Walston Switch | Moderate | Moderate | Rain barrels, buffer management & education, storm drain stenciling, tree planting in green space; Many geese and droppings near pond. | $ | High |
| SP_NSA_5 | Stonegate | Moderate | Moderate | Plant trees at BMP sites (ponds), storm drain stenciling. | $ | High |

$: Estimated Planning Level Cost < $5,000
$$: Estimated Planning Level Cost $5,000-$20,000
$$$: Estimated Planning Level Cost > $20,000

(a) (b) (c)

**Figure 4. 7. (a) Opportunity for stormwater treatment at SP_NSA_15; (b) Opportunity for tree planting around a stormwater pond at SP_NSA_5; and (c) Opportunity for ditch restoration at SP_NSA_6**

*Hotspot Site Investigation*

A total of 25 hotspot sites were assessed in the South Prong subwatershed. Two sites were identified as severe hotspots, two sites were identified as confirmed hotspots, and one site was identified as a potential hotspot. An additional 20 locations were assessed and not determined to be hotspots using the USSR criteria. Pollution producing behaviors that were noted include: outdoor commercial vehicle washing, lack of secondary containment, leaking dumpsters and a zoo exhibit that has direct interaction with the water (Figure 4. 8). Three stormwater retrofits were identified during the hotspot assessment (SP_HSI3, SP_RRI100 and SP_RRI101). Priority hotspot sites are shown in Table 4. and a full list of all sites assessed can be found in Appendix E.

**(a) (b)**

**Figure 4. 8. (a) Commercial vehicle washing on impervious cover (HSI_20a) and (b) improperly stored materials (HSI_20b)**

**Table 4. 8. Priority Hotspot Sites in the South Prong Subwatershed**

| Site_ID | Location | Type of Hotspot | Description | Recommended Actions | Status | Cost | Priority |
|---|---|---|---|---|---|---|---|
| SP_HSI_53 | Salisbury Zoo | Waste Management / Turf Landscaping | Animal exhibits have direct interaction with the river. Direct pollution source and contributor of bacteria. Large mammals and birds in exhibits | Exhibit should be moved if possible. Consideration could be given for treatment such as with floating wetlands. | Confirmed | $$$ | High |
| SP_HSI_40 | Center of Hope (Harvest Baptist Church at 119 South Blvd # A) | Outdoor Material Storage, Waste Management | Garbage on the ground; 50 gallon drum w/out secondary containment; evidence of dumpsters leaking; bulk material outside dumpster on ground | Suggest follow-up on-site inspection and discuss proper trash management; determine contents of 50 gallon drum & discuss proper management/storage | Severe | $ | High |
| SP_HSI_20C | Restaurants & Businesses near Hazel Avenue and South Salisbury Boulevard | Outdoor Material Storage, Waste Management | Dumpsters with broken lids, cooking oil in plastic container w/ lid down but evidence of oil spills and empty 5 gallon buckets with cooking oil residue; trash on ground around dumpster area | Schedule a review of stormwater pollution prevention plan; Suggest follow-up on-site inspection; discuss proper cooking oil and waste management; check out the pipe that has flow and algae to the right of dumpsters. | Confirmed | $ | Medium |
| SP_HSI_20A | Inside Out Car Care (726 South Salisbury Boulevard # G) | Vehicle Operations | Outdoor car wash that conveys the waste water to the parking lot storm drain (also visible from Google Earth view) | Schedule a review of stormwater pollution prevention plan; Suggest follow-up on-site inspection; divert water from storm drain and provide education. | Confirmed | $ | Medium |

$: Estimated Planning Level Cost < $5,000
$$: Estimated Planning Level Cost $5,000-$10,000
$$$: Estimated Planning Level Cost > $10,000

*Unified Stream Assessment*

Thirty-four stream reaches were initially identified in the South Prong subwatershed via a desktop assessment (Appendix B). Two of these "stream reaches," Schumaker Pond and Parker Pond, are actually impoundments and the stream reach assessment form is not applicable to these types of systems. Therefore, a stream reach form was not completed; however, impacts to the ponds from the surrounding watershed were assessed to the extent possible. Due to the limited amount of time available to conduct the stream assessments plus limited access on private property, field crews were not always able to walk entire stream lengths. In some cases, stream reaches were assessed from road crossings or by walking a short section of stream where property access had been granted.

Eight reaches that were assessed had no observable baseflow. These reaches were mostly in the headwaters. Two of these were marked as blue line streams in the GIS system, however, they appear to be intermittent streams. Other streams that were identified as intermittent actually had baseflow at the time of the field assessment. Two dry stream reaches were not assessed using the USA protocol due to time constraints.

An overall quantitative score for each reach was assigned based on average physical condition of various in-stream and riparian parameters (i.e. diversity of instream habitat, floodplain connectivity, vegetative buffer width, etc.). These scores were used to classify stream reaches into condition categories ranging from *excellent* to *very poor* (Table 4.).

The best reach score in the study area was SP_RCH15, which scored 150 points (Figure 4.9). This can be considered a representative score for the best attainable condition for a reach within the watershed. A score of at least 89% or greater than this number (≥134) is considered comparable to the reference condition and represents excellent stream conditions for the watershed. A score less than 19% (≤68 pts) of the reference score is considered very poor. Between these two extremes, 46% of the reference score (107≥68 pts) represents poor stream conditions, 71% of the reference score (122≥107 pts) represents fair stream conditions, and 81% of the reference score (134≥122 pts) represents good stream conditions.

**Table 4.9. Stream Reach Scoring Criteria**

| Classification | Percentile | Point Threshold |
|---|---|---|
| Excellent | 89% | ≥134 |
| Good | 81% | 122 ≥134 |
| Fair | 71% | 107 ≥122 |
| Poor | 46% | 69 ≥ 107 |
| Very Poor | 19% | ≤ 69 |

While these criteria serve to place the assessed reaches in context, they are somewhat subjective. A reach scoring a few points higher than another may be placed in a higher category, but the qualitative aspects of the method make differences of a few points insignificant. Maps of the stream reaches assessed and the observed impacts can be found in Appendix B.

(a) (b)

**Figure 4. 9. (a) RCH 13 - "excellent reach" and (b) channelized section of RCH4 - "poor" reach**

A total of 22 stream reaches were assessed in the South Prong subwatershed. Six reaches were assessed as excellent, two were assessed as good, one was assessed as fair, eleven were assessed as poor and two were assessed as very poor. Two additional reaches were visited but not assessed due to time constraints and no flow present in the stream channel. Stream reaches scoring low had problems with channelization, buffer encroachment, trash and armored banks. Stream reaches scoring higher had favorable habitat conditions, large, intact buffers, wetland habitat and river access to the floodplain. Seven high priority stream opportunities were identified (Table 4. 2). Numerous opportunities for buffer planting on private and public land were identified. A number of retrofit opportunities were identified at the airport for natural channel design and constructed wetlands. Invasive Japanaese knotweed was noted throughout the subwatershed with a significant seed source in the headwaters at SP_IB1701. Geese were also noted throughout the watershed and are contributors to nutrients and bacteria in the local streams and ponds.

A summary of notable restoration opportunities and stream impacts observed in the stream reaches are presented in Table 4. 1, Figure 4.10 and Figure 4.11. A complete list of the stream reaches assessed and the stream impacts observed can be found in Appendix E. Seven high priority and nine medium priority opportunities to restore the riparian corridor in the South Prong subwatershed were identified. Specific techniques prescribed to these seven locations include buffer planting, invasive plant removal, natural channel design and discharge inspection. Further study is needed to determine the most effective options at SC301, a sight west of the zoo on the mainstem of the South Prong. There is potential at this site to treat the majority of the subwatershed, however, due to the large drainage area and amount of water to be treated, further investigation into treatment opportunities are needed.

**Table 4. 10. Summary of Noted Stream Improvement Opportunities and Impacts**

| Impact Type | Site Description |
|---|---|
| Stream Buffer Restoration | • Impacted buffer identified along 15,190 linear feet of stream (2.9 miles)<br>• Invasive Japanese knotweed impacting buffer (SP_IB1701)<br>• Buffer mowed to edge (SP_IB701) |

| Table 4. 10. Summary of Noted Stream Improvement Opportunities and Impacts | |
|---|---|
| **Impact Type** | **Site Description** |
| Channel Modification | • Channel modification identified along 5,987 linear feet of stream (1.1 miles)<br>• Streams on the airport property (SP_CM3101) modified to concrete channel as well as other areas (SP_CM701)<br>• Lower river in downtown Salisbury completely armored (SP_IB101) |
| Stream Crossing | • Under-sized culverts acting as grade control and fish barriers (SP_SC601, SP_SC1501) |
| Discharge Investigation | • SP_OT1102[6], RCH-5<br>• Strong sewage odor noted in stormwater pond at the airport[7] |
| Other | • Beaverdam Creek feasibility study for water quality treatment options at SP_SC301 |


(a)


(b)

**Figure 4. 10. (a) Impacted buffer (IBI 701) has been overrun with invasive Japanese knotweed and (b) channel modification (CM 3101) at the airport**

| Table 4. 21. High Priority Stream Impacts in the South Prong Subwatershed | | | | | |
|---|---|---|---|---|---|
| **Site ID** | **Location** | **Impacts** | **Opportunity** | **Cost** | **Priority** |
| SP_IB2101 | Southwest of WorWic Community College | Impacted Buffer | Buffer Enhancement | $ | High |
| SP_IB2601 | Walston Switch Rd and Airport Rd | Impacted Buffer | Buffer Enhancement | $ | High |
| SP_IB301 | Between Snow Hill Rd and plastic fencing marking the downstream boundary of the zoo. | Impacted Buffer | Buffer Enhancement | $$ | High |
| SP_IB3101 | Along Fooks Rd | Impacted Buffer | Buffer Enhancement | $$ | High |

[6] Y3C1 and Y3C2 from Salisbury IDDE project
[7] Reported to City of Salisbury 6/28/2012. Resolution unknown.

**Table 4. 21. High Priority Stream Impacts in the South Prong Subwatershed**

| Site ID | Location | Impacts | Opportunity | Cost | Priority |
|---|---|---|---|---|---|
| SP_IB501 | Upstream of Memorial Plz | Impacted Buffer | Buffer Enhancement | $$ | High |
| SP_OT1102 | E College Ave | Outfall | Illicit discharge investigation | $ | High |
| SP_TR1301 | Downstream of Parker Pond on small tributary of RCH13 | Trash | Trash clean-up | $ | High |

$: Estimated Planning Level Cost < $2,000
$$: Estimated Planning Level Cost $2,000-$8,000
$$$: Estimated Planning Level Cost > $8,000

(a) (b) (c)

**Figure 4. 11. (a) Very poor stream reach with no buffer and hardened banks (SP_RCH_8); (b) Excellent stream reach with floodplain access and good buffer (SP_RCH_33); and (c) Opportunity for buffer enhancement (SP_IB_501)**

### *4.2.3. South Prong Protection Strategy*

Using the process identified above in Section 4.1.5, three high priority areas were identified for protection (1,558 acres); these areas are shown in Figure 4. 12. High priority areas 1 and 2 are areas that have been identified as important ecological areas that also support sensitive species. In addition, high priority area 1 is a large riparian corridor and high priority area 2 is a headwater stream. High priority area 2 contains a large portion of property that is already owned by Wicomico County so properties adjacent to those should be targeted. High priority area 3 is an important ecological area that is adjacent to a large protected area, the Nassawango Creek preserve owned by The Nature Conservancy that drains to the adjacent Pocomoke watershed. High priority area 3 does not contain blue line streams but drains to headwater streams of the South Prong. The area has large contiguous forest tracts that may be important for forest interior dwelling bird species. The remaining priority protection areas (2,153 acres) should be targeted for preservation efforts in order to maintain the current quality of the watershed and prevent further degradation.

GIS was used to identify the acres of protection area that are not currently protected via the State, municipalities, easements or other means. This analysis identified 1,211 acres of high priority land (77% of the originally identified area) to be protected and 1,904 acres of priority land (88% of the originally identified area) to be protected.

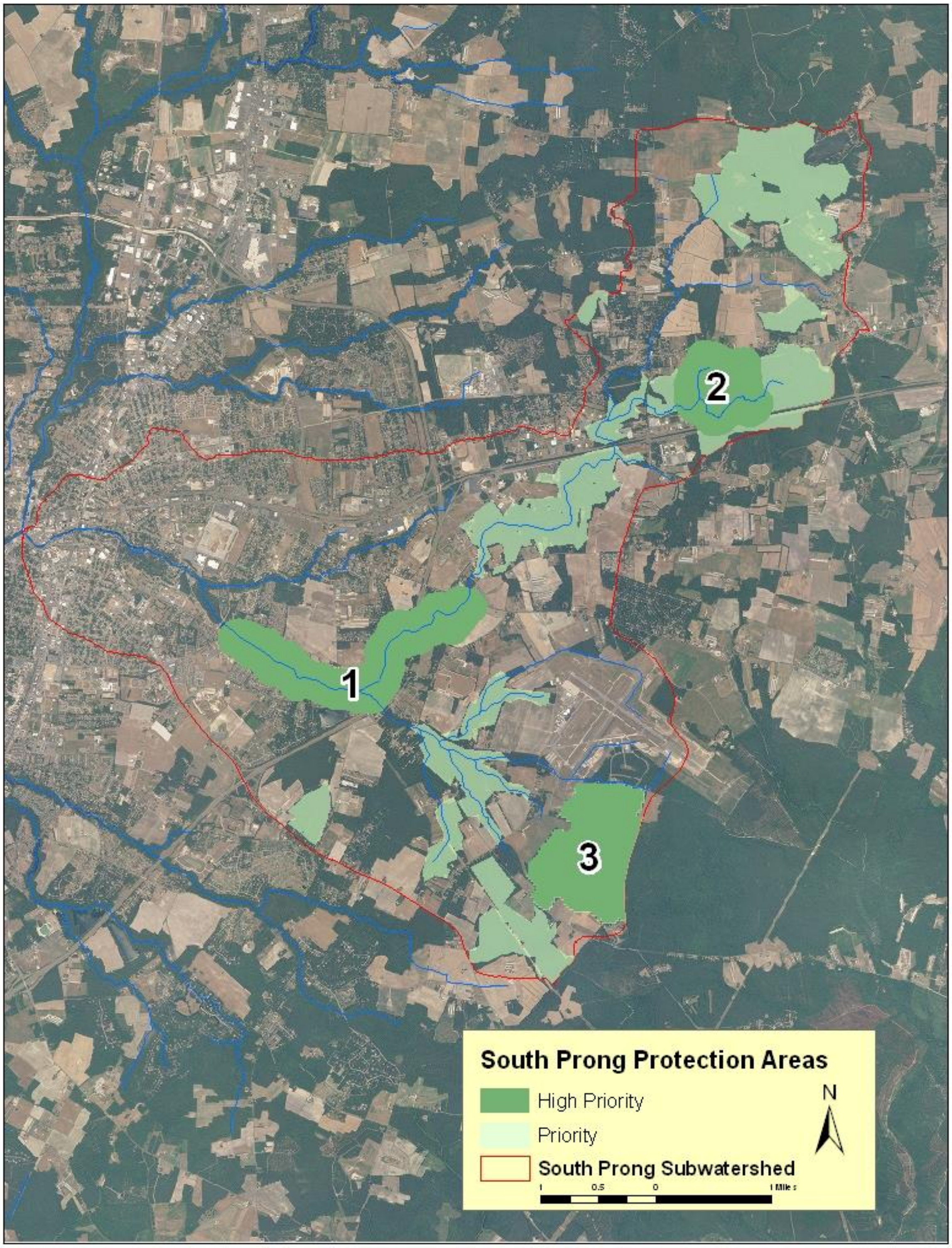
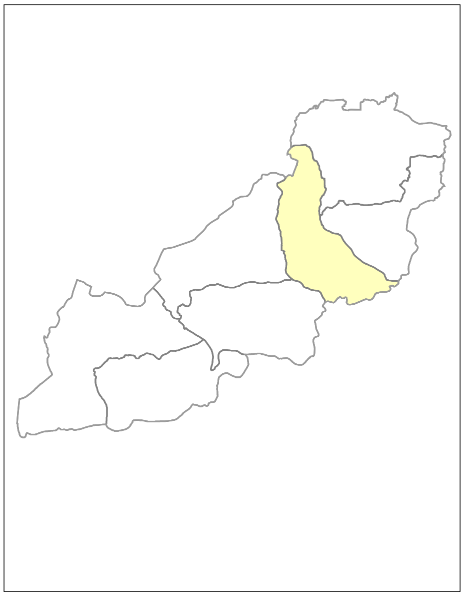



**Figure 4. 12. Priority areas for protection in the South Prong subwatershed**

## *4.3 Tony Tank Subwatershed Findings*

### *4.3.1 Tony Tank Overview*



| **Table 4. 12. Tony Tank Subwatershed Characteristics** | | |
|---|---|---|
| Drainage Area | | 18,564 acres |
| Existing Impervious Cover | | 1,845 acres (9.94%) |
| Stream Miles | | 37.68 miles |
| 2006 Land Use | Developed, Open Space | 16.7% |
| | Developed, Low Intensity | 10.9% |
| | Developed, Medium Intensity | 5.1% |
| | Developed, High Intensity | 1.7% |
| | Forest / Shrub | 21.8% |
| | Cropland and Pasture | 25.9% |
| | Woody & Herbaceous Wetlands | 9.9% |
| Jurisdictions as Percent of South Prong | | 15.6% Salisbury<br>11.7% Fruitland<br>72.9% Wicomico County |

The Tony Tank subwatershed is located in the central part of the Wicomico Watershed. The subwatershed boundary, as defined by the US Geological Survey mapping layers, spans the mainstem of the Wicomico River. From a management perspective, this delineation is not ideal and should be factored into management scenarios and monitoring restoration restoration progress and success. The Tony Tank has been classified as an Impacted Urban subwatershed, similar to the South Prong, for the Wicomico (see Characterization Report in Section 2). Nearly 16% of the subwatershed falls within the City of Salisbury, ~12% is within the City of Fruitland and the remaining 73% is contained within Wicomico County (Table 4. ). Land use is a mixture of developed (34.4% for all intensities) and cropland / pasture (25.9%). Forest cover (deciduous, evergreen, mixed and shrub/scrub) makes up an additional 21.8% and wetlands (woody and emergent herbaceous) cover 10% of the subwatershed. Soils are primarily in hydrologic soil groups A (have low runoff potential and high infiltration rates) and C (moderately high runoff potential, slow infiltration) (Table 4. ). There is a significant portion of D soils (high runoff potential, very slow infiltration) and these are found in the impervious developed areas of Salisbury and Fruitland as well as in southern headwaters (Figure 4. 13).

| **Table 4. 13. Soils in the Tony Tank Subwatershed** | |
|---|---|
| **Hydrologic Soil Group** | **Acres (%)[8]** |
| A | 5,941 (32.0%) |
| B | 2,246 (12.1%) |
| C | 5,506 (29.7%) |
| D | 4,287 (23.1%) |

[8] 582 acres of water not accounted for under soils.

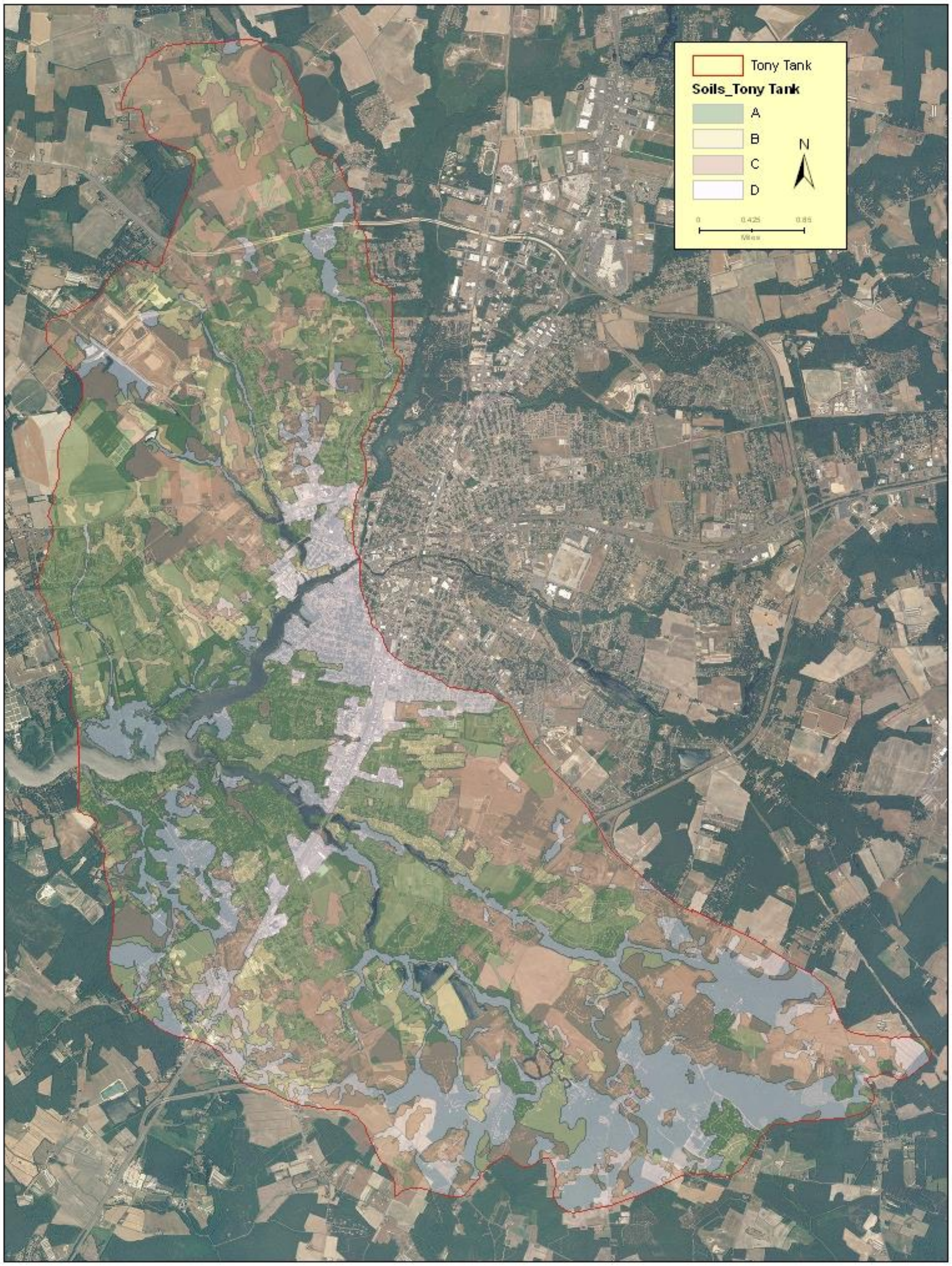



**Figure 4. 13. Soil Distribution across the Tony Tank subwatershed**

### *4.3.2 Tony Tank Field Assessments and Findings*

On October 16-17, 2012, field work was conducted in the 29 square mile Tony Tank subwatershed of the Wicomico River. The watershed field assessment strategy aimed to meet initial watershed restoration and protection goals outlined by the watershed planning Core Team and watershed stakeholders. These general watershed goals were to:

- Improve water quality;
- Protect existing resources; and
- Restore watershed function

During these field assessments, the field crew teams, consisting of one Center staff and volunteers from the Wicomico Environmental Trust, Cities of Fruitland and Salisbury, Wicomico County, the Coast Guard, and other interested individuals, visited over 168 locations in the watershed and used one of four field assessment methodologies to evaluate the feasibility of implementing a management or restoration practice. Approximately 54 potential stormwater retrofit sites, 19 potential hotspot locations, 24 residential neighborhoods, and 5.0 miles of stream (22 stream reaches) were assessed in the Tony Tank subwatershed. Table 4. 3 provides a summary of general findings from the field assessments.

**Table 4. 34. General Findings from Tony Tank Field Assessments**

| Task | General Findings |
|---|---|
| Stormwater Retrofit Inventory | • 54 sites visited<br>• 35 potential stormwater retrofits identified for 27 sites<br>• Focus on water quality treatment<br>• Identified 2 high priority projects and 23 medium priority projects<br>• Types of retrofits include bioretention areas, regenerative stormwater conveyance, infiltration, dry swales, existing stormwater pond retrofits, and impervious cover removal |
| Hotspot Site Investigation | • 19 potential hotspot sites investigated<br>• 18 sites identified as potential, confirmed or severe hotspots |
| Neighborhood Source Assessment | • 24 neighborhoods assessed<br>• Pollution severity index: 21 moderate, 3 high<br>• Neighborhood restoration potential: 4 low, 19 moderate and 1 high<br>• Types of recommendations include street sweeping or leaf pick-up, rain barrels, demonstration rain gardens, stormwater pond maintenance, free community trainings, storm drain stenciling, tree planting, buffer management, and nutrient/lawn homeowner management outreach |
| Unified Stream Assessment | • Assessed (via walking and boating) 5.0 miles of stream<br>• Assessed 22 stream reaches<br>• Completed site impact evaluations at 11 stream crossings, 1 modified channels, 3 erosion sites, 14 outfalls, 14 impacted buffers, 2 trash sites and 4 dams<br>• Identified 32 project, including 7 high priority riparian corridor projects<br>• Major findings include reaches are hydrologically disrupted throughout the subwatershed by dams and stream crossings. Areas of good habitat exist in lower tidal reaches and where buffers are wide with mature forest. Shoreline and lakeside shores have impacted buffers. Some areas of erosion and channel modification were noted. |

*Stormwater Retrofit Inventory*

A total of 54 stormwater retrofit sites were visited by field crews throughout the Tony Tank subwatershed and a total of 35 preliminary retrofit concepts were developed at 27 of the sites (Appendix F). Multiple concepts were developed for several of the sites and are indicated by a letter after the site number (i.e., TT-RRI-41B). There were no concepts developed for 27 sites that either had adequate stormwater management or significant site constraints such as access or feasibility. A map of the RRI sites visited is found in Appendix C.

Several stormwater retrofit opportunities identified in the watershed were identified on publicly-owned land in highly visible locations, such as public schools, parks, and municipal facilities. Some retrofit opportunities were identified on privately-owned land, in neighborhoods and commercial areas. Two high priority retrofit projects were identified throughout the subwatershed (Table 4. 4). These were located in Pemberton Park and include a regenerative stormwater conveyance and bioretention facility (Figure 4. 14). Both projects would serve as excellent demonstration sites due to their location. Many opportunities for providing stormwater treatment through bioretention practices were identified in several neighborhoods such as Pinebluff Village, Canal Park and Nutters Crossing. Opportunities for water quality treatment were also identified at municipal facilities such as the Wicomico Solid Waste Division, Wicomico County Roads Division Headquarters and Salisbury Municipal Yard. Several projects were identified at schools such as Fruitland Primary and Salisbury Middle School. These projects provide ample opportunity for student and public engagement, education and outreach regarding stormwater management and efforts to improve local water quality. A full list of the retrofit opportunities identified in the Tony Tank can be found in Appendix F.

(a) (b) (c)

**Figure 4. 14. (a) Location for regenerative stormwater conveyance at RRI_41a; (b) wooden box pipe to be removed at RRI_41a; (c) location for bioretention facility to treat parking lot runoff at RRI_41b**

**Table 4. 45. Priority Stormwater Retrofit Opportunities in the Tony Tank subwatershed**

| Site ID | Location | Retrofit Concept | Drainage Area (ac) | Impervious Cover (%) | Cost | TN Removal (lb/yr) | TP Removal (lb/yr) | TSS Removal (lb/yr) | Priority |
|---|---|---|---|---|---|---|---|---|---|
| TT_RRI_41A | Permberton Park | Regenerative Stormwater Conveyance | 0.56 | 95 | $ 11,294 | 1.99 | 0.23 | 64.05 | High |
| TT_RRI_41B | Permberton Park | Bioretention | 0.71 | 95 | $ 96,159 | 7.14 | 0.83 | 230.25 | High |
| TT_NSA_22B | Georgia Avenue Apartments | Bioretention | 0.90 | 10 | $ 10,805 | 1.16 | 0.14 | 37.55 | Medium |
| TT_NSA_23 | Playground - Riverside and Pennsylvania Ave | Bioretention | 0.61 | 25 | $ 83,424 | 2.29 | 0.27 | 73.76 | Medium |
| TT_NSA_32 | Nutters Crossing (Golf Course Club House) | Bioretention | 0.22 | 90 | $ 14,094 | 1.65 | 0.19 | 53.12 | Medium |
| TT_RRI_32A | Pinebluff Village | Bioretention | 0.52 | 25 | $ 6,715 | 1.05 | 0.12 | 33.75 | Medium |
| TT_RRI_32B | Pinebluff Village | Bioretention | 0.32 | 5 | $ 3,990 | 0.33 | 0.04 | 10.53 | Medium |
| TT_RRI_32C | Pinebluff Village | Bioretention | 0.20 | 85 | $ 17,654 | 1.62 | 0.19 | 52.31 | Medium |
| TT_RRI_38 | Fruitland Primary | Bioretention | 0.32 | 100 | $ 11,316 | 1.99 | 0.23 | 64.25 | Medium |
| TT_RRI_75B | Canal Park | Regenerative Stormwater Conveyance | 0.34 | 90 | $ 37,318 | 2.81 | 0.33 | 90.53 | Medium |
| TT_RRI_76 | Fruitland Water Treatment Plant | Bioretention | 0.30 | 100 | $ 47,684 | 3.29 | 0.38 | 106.10 | Medium |
| TT_RRI_31HSI | Seven Eleven (Nanticoke Road and South Salisbury Boulevard) | Infiltration | 0.29 | 100 | $ 30,028 | 3.02 | 0.45 | 117.14 | Medium |
| TT_RRI_53A | Wicomico Solid Waste Division | Wet Pond | 2.67 | 100 | $ 79,959 | 13.41 | 3.02 | 659.46 | Medium |

| **Table 4. 45. Priority Stormwater Retrofit Opportunities in the Tony Tank subwatershed** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Site ID** | **Location** | **Retrofit Concept** | **Drainage Area (ac)** | **Impervious Cover (%)** | **Cost** | **TN Removal (lb/yr)** | **TP Removal (lb/yr)** | **TSS Removal (lb/yr)** | **Priority** |
| TT_RRI_53B | Wicomico Solid Waste Division | Dry Swale | 3.64 | 95 | $ 54,623 | 20.75 | 2.65 | 723.29 | Medium |
| TT_RRI_55 | Salisbury Marina | Bioretention | 1.35 | 100 | $ 207,304 | 14.57 | 1.69 | 470.10 | Medium |
| TT_RRI_48 | Salisbury Middle School | Impervious Cover Removal | 0.22 | 100 | $ 21,172 | 2.66 | 0.36 | 78.37 | Medium |
| TT_RRI_54B | Salisbury Plaza | Impervious Cover Removal | 0.14 | 0.14 | $ 727 | 0.09 | 0.01 | 2.69 | Medium |
| TT_RRI_44 | Wicomico Nursing Home | Bioretention | 0.98 | 95 | $ 70,966 | 8.02 | 0.93 | 258.66 | Medium |
| TT_RRI_51 | Wicomico County Roads Division HQ | Filtering Practice | 3.33 | 100 | $ 25,360 | 5.90 | 1.59 | 348.14 | Medium |
| TT_RRI_52A | Lower Shore Enterprise | Extended Detention Pond | 3.10 | 85 | $ 881,441 | 5.36 | 1.09 | 791.33 | Medium |
| TT_RRI_74 | Maryland Food Bank of Eastern Shore | Dry Swale | 0.75 | 90 | $ 20,219 | 5.23 | 0.67 | 182.25 | Medium |
| TT_RRI_29_1a | 405 Camden Ave | Bioretention | 0.19 | 100 | $ 13,102 | 1.57 | 0.18 | 50.77 | Medium |
| TT_RRI_29_1b | 405 Camden Ave | Bioretention | 0.20 | 100 | $ 17,805 | 1.82 | 0.21 | 58.61 | Medium |
| TT_RRI_4_1 | Lakewood and Arbutus Dr | Regenerative Stormwater Conveyance | 1.68 | 25 | $ 22,770 | 8.11 | 1.09 | 239.11 | Medium |

*Neighborhood Source Assessment*

A total of 24 neighborhoods were visited by the field crews. A list of the assessed neighborhoods can be found in Appendix F. The assessed neighborhoods were predominantly a mix of older and newer single family homes, as in the South Prong, but also contained student housing associated with Salisbury University, as well as some subsidized (Section 8) housing. The Tony Tank neighborhoods assessed tended to rate as moderate in terms of pollution severity. Three neighborhoods received a rating of high for pollution severity, mostly due to high amount of grass cover in yards and lawns, highly managed turf lawns, evidence of sediment/organic matter in the curb and gutter, and field observed pollution indicators.

Neighborhoods generally rated moderate for restoration potential, with one rating high and four rating low. Opportunities identified in moderate neighborhoods included rain barrels, rain gardens, tree planting, nutrient and lawn management education and storm drain stenciling (Figure 4.15). Restoration opportunities in the neighborhoods rated low for restoration potential were limited in opportunity primarily because they were multi-family homes with less opportunity per lot, they were brand new homes where landowners may not be anxious for change, or they had high tree canopy cover that may impede projects such as rain gardens because of low light levels. One neighborhood was identified in the Tony Tank subwatershed with high priority restoration actions (Table 4. 5). Restoration opportunities in this neighborhood include stormwater pond maintenance, tree planting, street sweeping, ditch restoration, storm drain stenciling and outreach regarding lawn maintenance.

**Table 4. 56. Neighborhood Source Control Opportunities in Tony Tank**

| Site_ID | Location | Pollution Severity | Restoration Potential | Opportunity | Cost | Priority |
|---|---|---|---|---|---|---|
| TT_NSA_22 | River Oak, Oak Hills, Riverside Homes - River Oak Court, Alabama Ave, Georgia Ave | Moderate | Moderate | Rain gardens or bioswale between Oak Hills Townhome buildings, retrofit concrete channel that drains parking lot directly to river or add buffering along river, tree planting in open area at River Oak, stencil storm drain inlets, highly maintained lawns. | $ | High |
| TT_NSA_29 | Village at Tony Tank Creek - Village Oak Drive, Sandy Bottom Court | Moderate | Moderate | Rain barrels, over manicured lawns, tree planting or rain garden in large traffic circle (currently just lawn), downspouts to pervious, buffering and trash clean up in storm water ponds, stencil storm drain inlets, non-target irrigation | $ | High |

**Table 4. 56. Neighborhood Source Control Opportunities in Tony Tank**

| Site_ID | Location | Pollution Severity | Restoration Potential | Opportunity | Cost | Priority |
|---|---|---|---|---|---|---|
| TT_NSA_37 | Willow Creek - Willow Creek Drive, Oxbridge Drive | High | High | Neighborhood stormwater pond needs maintenance at inlets and could use more buffering/tree planting, rain barrels, septic maintenance, better irrigation practices, street sweeping, ditches have concrete bottoms (retrofit opportunity), large church property drains to pond - retrofits/buffering opportunities, church trash/dumping in back of property, tree planting | $$ | High |
| TT_NSA_42 | Village at Mitchell Pond - Parsons Road | Moderate | Moderate | Some bare soil - rehab walkways or redirect pedestrian traffic - precipitation erodes the soil to storm water inlets, better parking lot maintenance/long term parking, dumpsters are not covered and drain to storm water inlet | $ | High |
| TT_NSA_44-A | Duke Drive, Esquire Drive, Duchess Drive | Moderate | Moderate | Rain barrels, tree planting, downspouts to pervious, stencil storm drain inlets, septic maintenance, street sweeping | $ | High |
| TT_NSA_44-B | Sassafras Meadows - Marquis Avenue | Moderate | Moderate | Tree planting, rain barrels, rain gardens, move downspouts to pervious/landscaping, stencil storm drain inlets | $$ | High |

(a) (b) (c)

**Figure 4. 15. (a) Opportunity for outreach regarding lawn maintenance at TT_NSA_37; (b) dirty parking lots at TT_NSA_39; and (c) ample opportunity for tree planting at TT_NSA_22**

*Hotspot Site Investigation*

A total of 19 hotspot sites were assessed in the Tony Tank subwatershed. Six sites were identified as severe hotspots, 10 sites were identified as confirmed hotspots, two sites were identified as potential hotspots and one site was not a hotspot. Pollution producing behaviors that were noted include: storage of outdoor materials in unlabeled containers without containment, poor trash management, uncovered materials, stains and other evidence of leakage and illegal dumping (Figure 4.16 and Table 4.17). Priority hotspot sites are shown in and a full list of all sites assessed can be found in Appendix F.

**(a)**


**(b)**

**(c)**

**Figure 4. 16. (a) Municipal vehicle washing on impervious surface (TT_HSI_67); (b) batteries stored outside without cover or containment (TT_HSI_22b); and (c) poor trash management (TT_HSI_22a)**

**Table 4. 67. Priority Hotspot Sites in the Tony Tank Subwatershed**

| Site_ID | Location | Type of Hotspot | Description | Recommended Actions | Status | Cost | Priority |
|---|---|---|---|---|---|---|---|
| TT_HSI_68 | Wicomico Co. Roads Division HQ | Vehicle Operations, Outdoor Material Storage | County's Road Division Headquarters, where equipment and trucks are stored and maintained, also contains covered fueling station | Schedule a review of the SWPPP, pollution prevention training for employees, provide additional cover for outdoor materials, implement retrofit project. | Potential | $ | High |
| TT_HSI_67 | Wicomico Co. Solid Waste Recycling Yard | Vehicle Operations, Waste Management | County transfer station for household recyclable materials as well as the depot for organic waste. | Check on NPDES status, schedule a review of the SWPPP; Pollution prevention training for employees; Implement wash pond retrofit | Confirmed | $$$ | High |
| TT_HSI_66 | Salisbury Municipal Yard | Vehicle Operations/Waste Management | City's municipal yard where they store trucks and equipment. They also store construction materials and bulk waste that they collect from the ROW | Check on NPDES status, schedule a review of the SWPPP, suggest follow-up inspection; Pollution prevention training for employees | Confirmed | $$ | High |
| TT_HSI_22B | PASCO (1121 South Salisbury Boulevard) | Outdoor Material, Waste Management | Storing car batteries outside on wooden pallets | Suggest follow-up on-site inspection and discuss proper car battery storage | Confirmed | $ | High |
| TT_HSI_22A | 1147 University Square | Outdoor Material Storage, Waste Management | Poor trash management at the site; trash on the ground around dumpster; two dumpsters in standing water; 50 gallon drum was full, with open top, unlabeled, and rusting | Schedule a review of stormwater pollution prevention plan; follow up site inspection; discuss proper waste management and potential to move dumpsters out of standing water or move water away from area | Severe | $ | High |
| TT_HSI_21 | Salisbury University | Outdoor Material Storage | Compost/mulch pile is uncovered and drains to storm drain | Schedule a review of stormwater pollution prevention plan; follow up site inspection; discuss using berm to manage storm flows | Confirmed | $ | High |

*Unified Stream Assessment*

Twenty-two stream reaches were assessed in the Tony Tank subwatershed. Field crews were only able to assess streams from public properties and right-of-ways so assessments are not complete or necessarily indicative of the entire stream reach. In addition, assessments were limited amount by the amount of time available vs the size of the subwatershed and total lengths of streams. Contrary to the South Prong assessment however, a boat was made available by the Coast Guard Auxiliary group and the entire Tony Tank portion of the Wicomico mainstem was able to be assessed in this manner.

Five reaches that were assessed had no observable baseflow. These reaches were mostly in the headwaters and were marked as blue line streams in the GIS system, however, they appear to be intermittent streams. These dry stream reaches were not assessed using the USA protocol due to time constraints. In addition, one identified blue line stream was actually a wetland and not assessed using the USA protocols.

An overall quantitative score for each reach was assigned based on average physical condition of various in-stream and riparian parameters (i.e. diversity of instream habitat, floodplain connectivity, vegetative buffer width, etc.). These scores were used to classify stream reaches into condition categories ranging from *excellent* to *very poor* (Table 4. 7, Figure 4.17).

The best reach score in the study area was TT_RCH18, which scored 143 points. This can be considered a representative score for the best attainable condition for a reach within the watershed. A score of at least 89% or greater than this number (≥127) is considered comparable to the reference condition and represents excellent stream conditions for the watershed. A score less than 19% (≤65 pts) of the reference score is considered very poor. Between these two extremes, 46% of the reference score (66≥101 pts) represents poor stream conditions, 71% of the reference score (102≥115 pts) represents fair stream conditions, and 81% of the reference score (116≥126 pts) represents good stream conditions.

**Table 4. 78. Stream Reach Scoring Criteria**

| Classification | Percentile | Point Threshold |
|---|---|---|
| Excellent | 89% | ≥127 |
| Good | 81% | 116 ≥126 |
| Fair | 71% | 102 ≥115 |
| Poor | 46% | 66 ≥ 101 |
| Very Poor | 19% | ≤ 65 |

While these criteria serve to place the assessed reaches in context, they are somewhat subjective. A reach scoring a few points higher than another may be placed in a higher category, but the qualitative aspects of the method make differences of a few points insignificant. Maps of the stream reaches assessed and the observed impacts can be found in Appendix C.

(a) (b) (c)

**Figure 4. 17. (a) RCH_33 - "excellent reach;" (b) trash in RCH_37 - "poor" reach; and (c) "fair" tidal RCH_26**

A total of 22 stream reaches were assessed in the Tony Tank subwatershed. Three reaches were assessed as excellent, three were assessed as good, three were assessed as fair, six were assessed as poor and one was assessed as very poor. Stream reaches scoring low had problems with buffer encroachment, eutrophication, sedimentation, and trash. Reach 46 begins in downtown Salisbury at the confluence of the North and South Prongs. This reach is in very poor condition with significant impacts from industry, a marina, parking lots, commercial and residential development. Chesapeake Shipbuilders is a significant hotspot and no buffer is provided between their operations and the river. Stream reaches scoring higher had favorable habitat conditions, large, intact buffers, wetland habitat and river access to the floodplain.

A summary of notable restoration opportunities and stream impacts observed in the stream reaches are presented in Table 4.. A complete list of the stream reaches assessed and the stream impacts observed can be found in Appendix F. Five high priority and seventeen medium priority opportunities to restore the riparian corridor in the Tony Tank subwatershed were identified. Specific techniques prescribed to these locations include buffer planting, invasive plant removal, fish barrier removal and discharge inspection.

**Table 4.19. Summary of Noted Stream Improvement Opportunities and Impacts**

| Impact Type | Site Description |
|---|---|
| Stream Buffer Restoration | • Impacted buffer identified along 30,866 linear feet of stream (5.8 miles)<br>• Widespread invasives impacting buffer (TTIB36_1)<br>• Wetland restoration through removal of invasive Phragmites at Pemberton Park (TTIB48_1) could be coupled with high priority stormwater retrofit projects (TT_RRI41A and TT_RRI_41B)<br>• Conservation landscaping and / or living shoreline opportunities identified throughout |
| Channel Modification | • One channel modification identified (TTCM13_1) near Canal Woods development. Area requires further study to determine if relief points can be added to deter localized flooding. |

| Table 4.19. Summary of Noted Stream Improvement Opportunities and Impacts | |
|---|---|
| **Impact Type** | **Site Description** |
| Stream Crossing | • Under-sized culverts acting as grade control and partial to full fish barriers[9] (TTSC36_1, TTSC30_1, TTSC43_1 and TTSC44_1). Four dams identified but more noted on aerial photography. |
| Discharge Investigation | • TTOT39_1B[10], TTOT39_1a and poor pool quality at TTOT36_1c (may indicate an intermittent discharge) |
| Trash | • Trash clean-up (TTTR36_1 and TTTR40_1) |
| Other | • Poor water quality at Colbourne Mill Pond. Deliver workshops to local residents on septic maintenance. Consider opportunities for fountains/aeration and/or floating treatment wetlands to absorb nutrients. |

As noted above, five high priority stream opportunities were identified (Table 4. ). On the Wicomico mainstem, Chesapeake Shipbuilders is a severe hotspot (see *Hotspot site Investigation* above) that drains to the critical area as well as high priority protection areas. Residential areas on the opposite bank have managed lawns to the edge of the bank and opportunities for adding buffer and/or living shorelines should be explored with these landowners. The Canal Woods Park development is surrounded by the river on three sides and flooding has been noted by the City in this area. Opportunities to reduce flooding in this development were beyond the scope of this study but the City and neighborhood may wish to explore the potential to offer relief points either upstream of the development or under Route 13. Other restoration opportunities noted in the development include buffer enhancement on the north and south sides of the development. In addition, wetland benches could be added instream on the south side of the development to add complexity, refugia and nutrient absorption. A stormwater retrofit was identified as well (TT_RRI_75b). Several stream opportunities were noted near the intersection of Rose St and Delaware Ave. The stream in this location is degraded and ample opportunities are present to involve the local neighbors in trash clean up and buffer restoration. In addition, erosion was noted around an outfall and an outfall stabilization project could be added to the overall effort.

| Table 4. 20. Priority Stream Opportunities in the Tony Tank Subwatershed | | | | | | |
|---|---|---|---|---|---|---|
| **Reach ID** | **Site ID** | **Location** | **Impact** | **Opportunity** | **Cost** | **Priority** |
| TT_RCH46 | TTIB46_1 | Mainstem Wicomico from downtown Salisbury to edge of natural gas facility | Impacted Buffer | Buffer enhancement / hotspot management | $$$ | High |
| TT_RCH13 | TTIB13_1 | Canal Woods Park | Impacted Buffer | Buffer enhancement / wetland benches | $$ | High |

[9] Additional research is needed to determine what fish species of concern may, if at all, be impacted by these barriers. Maryland Department of Natural Resources should be contacted for more information.
[10] Reported to the City of Salisbury on 10/24/2012. Resolution unknown.

| Table 4. 20. Priority Stream Opportunities in the Tony Tank Subwatershed | | | | | | |
|---|---|---|---|---|---|---|
| **Reach ID** | **Site ID** | **Location** | **Impact** | **Opportunity** | **Cost** | **Priority** |
| TT_RCH36 | TTIB36_1 | Rose St and south | Impacted Buffer | Buffer enhancement | $ | High |
| TT_RCH5 | TTIB5_1 | Colbourne Mill Pond | Impacted Buffer | Buffer enhancement | $$ | High |
| TT_RCH36 | TTTR36_1 | Rose St | Trash | Trash clean-up | $ | High |

**(a) (b) (c)**

**Figure 4. 18. (a) Hotspot operation and impacted buffer (IB46-1); (b) impacted buffer in Canal Woods development (IBI3_1) and (c) opportunity to engage local neighbors in a volunteer trash clean-up (TR36_1)**

### *4.3.3. Tony Tank Protection Strategy*

Using the process identified in Section 4.1.5, several high priority areas (1,535 acres) were identified for protection; these areas are shown in Figure 4. 19. Two large areas were identified as high priority protection areas (#1 and #2) and two smaller areas (#3 and #4). Area # 1 is in the vicinity of Pemberton Park, a County park where a number of projects were identified above. These projects are particularly important because they will help to maintain overall ecological integrity. GIS was used to identify the acres of protection area that are not currently protected via the State, municipalities, easements or other means. This analysis identified 1,305 acres of high priority land (85% of the originally identified area) to be protected and 2,125 acres of priority land (73% of the originally identified area) to be protected.

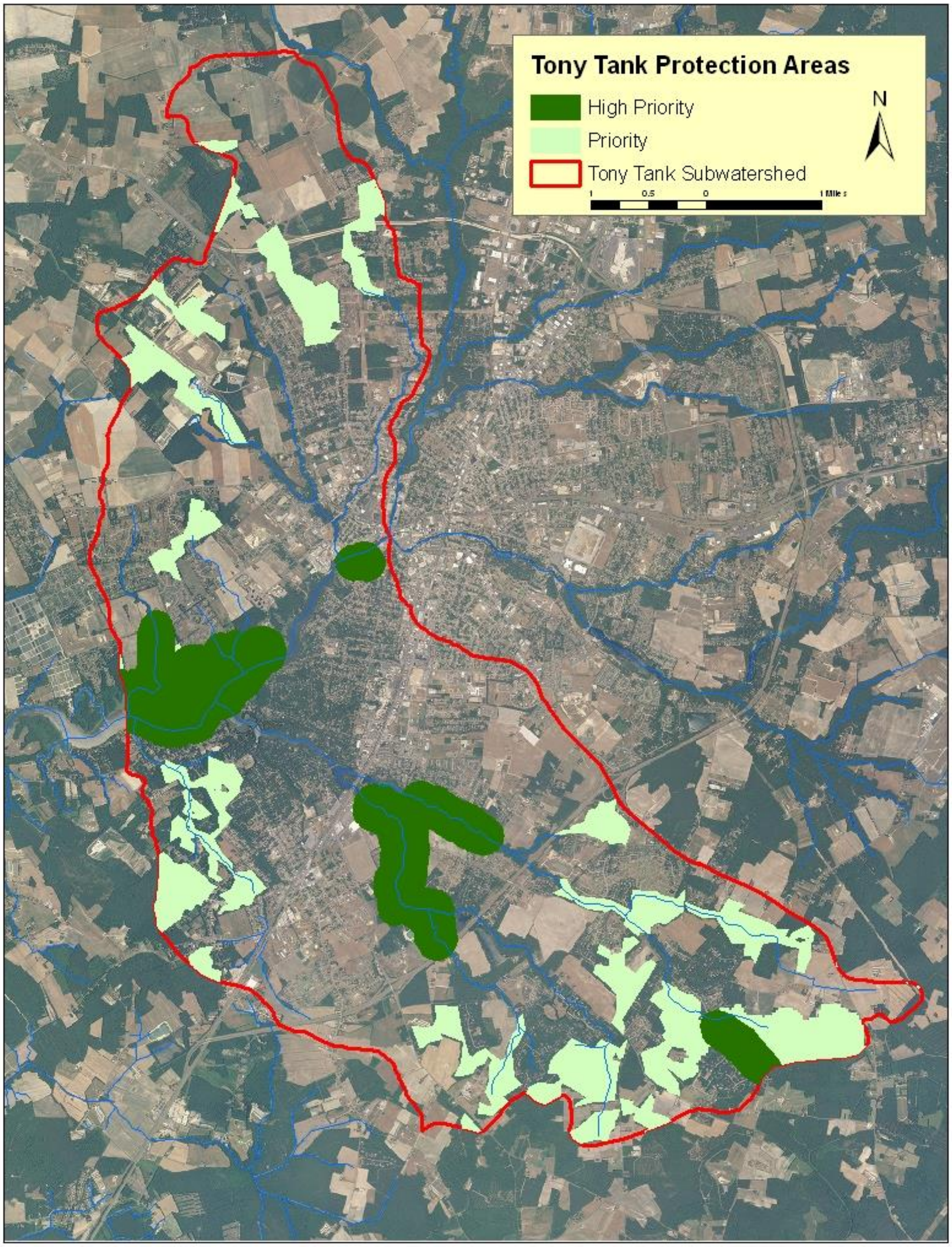



**Figure 4. 19. Priority areas for protection in the Tony Tank subwatershed**

## *4.4 North Prong Subwatershed Findings*

### *4.4.1 North Prong Overview*

| **Table 4.21. North Prong Subwatershed Characteristics** | | |
|---|---|---|
| Drainage Area | | 24,834 acres |
| Existing Impervious Cover | | 1,947 acres (7.84%) |
| Stream Miles | | 44.8 miles |
| 2006 Land Use | Developed, Open Space | 10.2% |
| | Developed, Low Intensity | 6.3% |
| | Developed, Medium Intensity | 4.0% |
| | Developed, High Intensity | 2.6% |
| | Forest / Shrub | 28.9% |
| | Cropland and Pasture | 34.4% |
| | Woody & Herbaceous Wetlands | 12.0% |
| Jurisdictions as Percent of North Prong | | 14.2% Salisbury<br>4.3% Delmar<br>76% Wicomico County |

The North Prong has been classified as an Impacted/Rural Mix subwatershed (CWP, 2013). Most of the watershed is in the County (76%), with 14% in the City of Salisbury and 4% in Delmar. Land use is a mixture of forest and shrub (29%), cropland and pasture (34%) and is less developed than the South Prong and Tony Tank (Table 4.21). Soils are primarily in hydrologic soil groups C (moderately high runoff potential, slow infiltration) and D (high runoff potential, very slow infiltration) (Table 4. ). Hydrologic group A soils have low runoff potential and high infiltration rates and B soils have moderately low runoff potential and moderate infiltration rates. Figure 4.20 shows the distribution of soils across the subwatershed.

| **Table 4.22. Soils in the North Prong Subwatershed** | |
|---|---|
| **Hydrologic Soil Group** | **Acres (%)** |
| A | 5,942 (23.9%) |
| B | 3,187 (12.8%) |
| C | 8,086 (32.6%) |
| D | 7,412 (29.8%) |

The North Prong is listed as impaired in the Maryland 303(d) list of impaired waters for three pollutants of concern: Phosphorus (2002), Sediment/ (2002) and Fecal Coliform (2006). To date, there are no TMDL implementation plans developed to address the impairments and meet water quality goals.

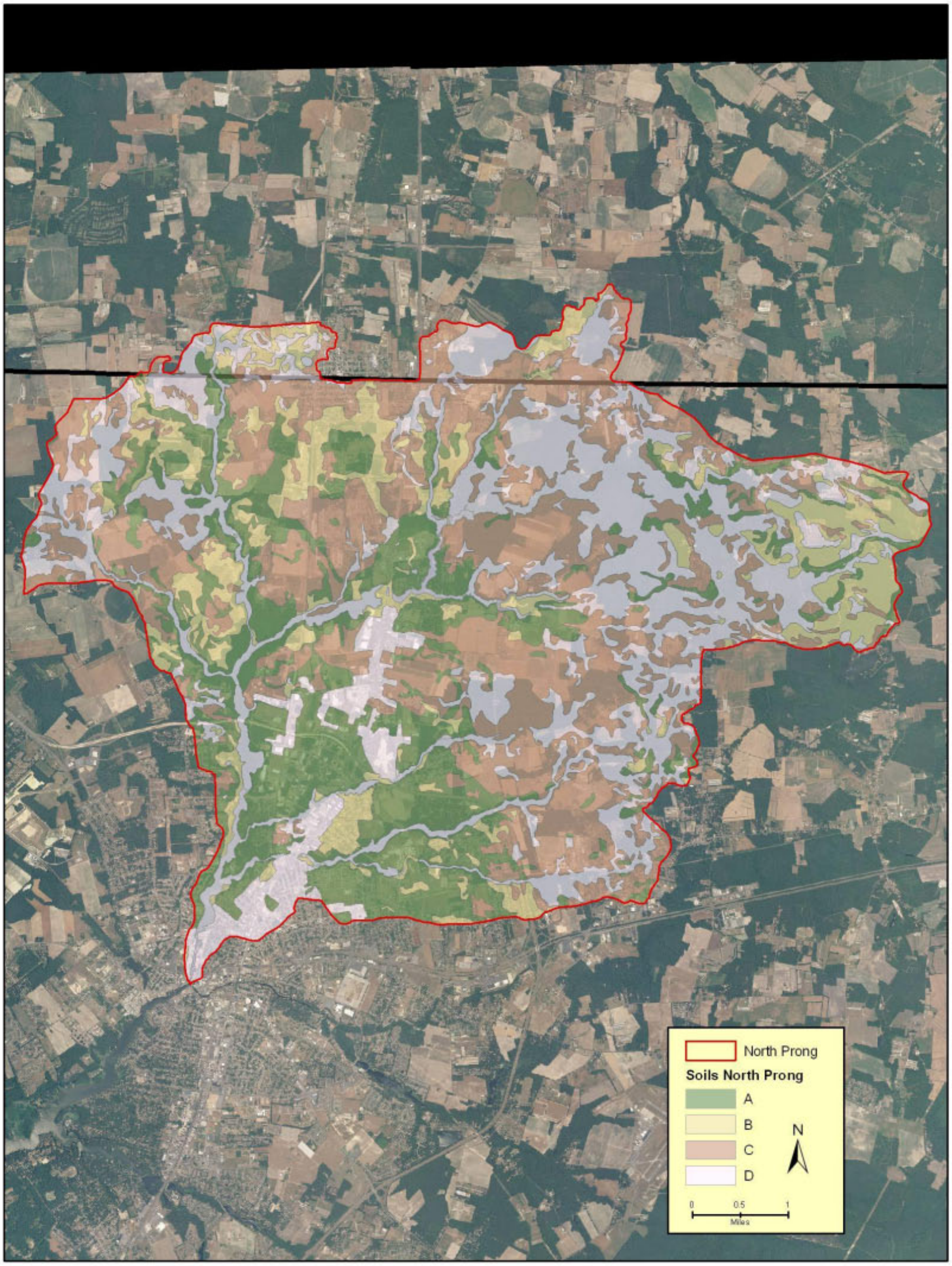



**Figure 4.20. Soil distribution across the North Prong subwatershed**

*4.4.2. North Prong Field Assessments and Findings*

On November 14-15, 2013, field work was conducted in the North Prong subwatershed. During these field assessments, the field crew teams, consisting of one Center staff and one or more volunteers from WET, the City and the County visited over 155 locations in the watershed and used one of four field assessment methodologies to evaluate the feasibility of implementing a management or restoration practice. Approximately 51 potential stormwater retrofit sites, 29 potential hotspot locations and 35 residential neighborhoods were assessed in the North Prong subwatershed. Table 4.23 provides a summary of general findings from the field assessments.

**Table 4.23 General Findings from North Prong Field Assessments**

| Task | General Findings |
|---|---|
| Stormwater Retrofit Inventory | • 70 sites visited<br>• 51 potential stormwater retrofits identified for 33 sites<br>• Types of retrofits include permeable pavement, stormwater planters, stormwater pond enhancements and conversions, bioretention, infiltration, regenerative stormwater conveyance, impervious cover removal, and floating treatment wetlands |
| Hotspot Site Investigation | • 29 potential hotspot sites investigated<br>• 9 sites identified as potential, confirmed, or severe hotspots primarily related to waste management, vehicle activities and the storage of outdoor materials |
| Neighborhood Source Assessment | • 35 neighborhoods assessed<br>• Pollution severity index: 14 low, 18 moderate, 3 high<br>• Neighborhood restoration potential: 15 low and 20 moderate<br>• Neighborhoods ranged in age from <10 - 75 years old.<br>• Types of recommendations include pond maintenance, rain barrels, demonstration rain gardens, street sweeping, downspout disconnection, storm drain stenciling, tree planting, septic education, and nutrient/lawn management. |
| Unified Stream Assessment | • Surveyed 7.8 miles of stream<br>• Assessed 21 stream reaches<br>• Completed site impact evaluations at 6 stream crossings, 6 impacted buffers, 6 trash sites, 1 modified channel, 1 erosion site, and 1 utility crossing<br>• Identified 18 projects, including 7 high priority riparian corridor projects, trash, limited or no buffer and/ or prevalent invasive species. Stream reaches scoring higher had favorable habitat conditions, large, intact buffers, and wetland habitat and river access to the floodplain. Invasive species were noted throughout the subwatershed, including English ivy, mimosa, Japanese knotweed, ailanthus, and phragmites. |

*Stormwater Retrofit Assessment*

A total of 70 stormwater retrofit sites were visited by field crews throughout the North Prong subwatershed and a total of 51 preliminary retrofit concepts were developed at 33 of the sites. Multiple concepts were developed for several of the sites and are indicated by a letter after the site number (i.e., NP-RRI-19B). Altogether, the proposed retrofit projects would treat 138 new acres, 53 acres of which are impervious. There were no concepts developed for 19 sites that either had adequate stormwater management or significant site constraints such as access or feasibility. A map of the RRI sites visited is found in Appendix D.

Stormwater retrofit opportunities were identified in commercial areas along Rt. 13 and in downtown Salisbury; private institutions such as churches; public properties such as the Water Treatment Plant, parks and tourism office; schools; and one State property (Deers Head Hospital). Ten high priority retrofit projects were identified throughout the subwatershed (Table 4.24). A full list of the retrofit opportunities identified in the North Prong can be found in Appendix G. A summary of costs and water quality benefits of the projects based on ownership breakdown is provided in Table 4.24.

Some general observations from the stormwater retrofit assessment are noted below:

- Throughout the watershed, a lack of stormwater treatment was observed in many locations. At many of these sites, untreated stormwater discharges directly to forested buffers, stream channels, or the stormdrain system. Unmanaged stormwater can contribute high pollutant loads to the receiving waterbodies, and can also result in high stormwater runoff flow rates that cause streambank erosion and degrade stream habitat.
- Several opportunities were identified at institutions, including:
    - Bioretention at Delmarva Evangelistic Church, E. Gordy Dr. (NP_RRI_24a); and
    - Infiltration and regenerative stormwater conveyance at Deers Head Hospital (NP_RRI_34a and 34b).
- Numerous opportunities were also identified at schools, including:
    - Stormwater planters at East Salisbury Elementary School (NP_RRI_7); and
    - Infiltration at North Salisbury Elementary (NP_RRI_23).
- Several notable opportunities for improving water quality include the following:
    - Bioretention along commercial, constrained sections of stream such as Pep Boys (NP_RRI_101a);
    - Bioretention at the water treatment plant off Naylor Mill Rd (NP_RRI_19b)
    - Infiltration at Winter Place Little league Park (NP_RRI_51);
    - Infiltration at Deers Head Hospital (NP_RRI_34a);
    - Bioretention at the Wicomico Tourism Office (NP_RRI_1);
    - Stormwater planters at the Salisbury Mall (NP_RRI_17b); and
    - Bioretention at Naylor Mill Rd and Goddard Pkwy (NP_RRI_103).
- Management measures to improve existing stormwater management facilities were noted throughout the subwatershed. These improvements are difficult to quantify in terms of creditable pollutant load reductions but are considered best practices for improving water quality. These management measures are displayed in Tables 4.25.

**Table 4.24 Priority Stormwater Retrofit Opportunities in the North Prong**

| Site ID | Location | Jurisdiction | Retrofit Concept | Drainage Area (ac) | Impervious Cover (%) | % WQv Treated | Cost | TN Removal (lb/yr) | TP Removal (lb/yr) | TSS Removal (lb/yr) | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RRI_19A | Water Treatment Plant at W. Naylor Mill Rd and Scenic Dr. | Salisbury | Bioretention | 0.33 | 60% | 1.04 | $ 19,914.60 | 2.85 | 0.27 | 204.47 | High |
| RRI_19B | Water Treatment Plant at W. Naylor Mill Rd and Scenic Dr. | Salisbury | Bioretention | 0.24 | 20% | 2.52 | $ 19,914.60 | 1.94 | 0.13 | 55.59 | High |
| RRI_51 | Winter Place Little League Park | County | Infiltration | 2.66 | 58% | 0.17 | $ 13,707.23 | 8.45 | 0.78 | 586.69 | High |
| RRI_7 | East Salisbury Elementary School, 1201 Old Ocean City Road | Salisbury | Stormwater Planter | 0.35 | 100% | 0.10 | $ 4,406.71 | 0.66 | 0.08 | 67.27 | High |
| RRI_23 | North Salisbury Elementary West of N. Division Street on Livingston Street | Salisbury | Infiltration | 0.07 | 100% | 1.97 | $ 6,153.41 | 0.80 | 0.09 | 80.51 | High |
| RRI_34A | Deers Head Hospital (Northwest parking lot) | State | Infiltration | 0.60 | 100% | 0.73 | $ 19,047.55 | 5.30 | 0.59 | 529.50 | High |
| RRI_34B | Deers Head Hospital (South of hospital) | State | Regenerative Stormwater Conveyance | 0.45 | 100% | 0.26 | $ 17,839.13 | 2.07 | 0.23 | 206.56 | High |
| RRI_8 | Doverdale Park at Dover Street and Vaden Street | Salisbury | Permeable Pavers | 0.04 | 100% | 20.26 | $ 157,543.47 | 0.42 | 0.05 | 40.89 | High |
| RRI_1 | Wicomico Tourism Center | County | Bioretention | 0.68 | 93% | 0.10 | $ 5,526.33 | 1.35 | 0.15 | 130.87 | High |
| RRI_10A | Corrections/Detention Center | County | Constructed Wetlands | 4.20 | 34% | 1.46 | $ 128,935.14 | 20.34 | 2.12 | 1507.70 | High |

**Table 4.25 Modifications to Existing Stormwater Management Facilities**

| Site ID | Location | Jurisdiction | Description |
|---|---|---|---|
| NP_RRI_12 | Delmar Elementary | Delmar | Convert dry pond by adding plantings |
| NP_RRI_300 | Delmar Commons Shopping Center | Delmar | Add plants to bottom of wet pond to increase filtering |
| NP_RRI_301 | Anderson Recycling Old Racetrack Road | Delmar | Replace gravel lot with permeable material or plant trees |
| NP_RRI_302 | SW Pond in NSA_7 neighborhood | Delmar | Redesign pond to remove pipe that allows drainage to short circuit treatment in pond |
| NP_RRI_28C | Lowes | Salisbury | Add floating wetlands |
| NP_RRI_303 | 2 Pond Conversions | Salisbury | Add floating wetlands |
| NP_RRI_304 | Gander Mountain Pond | Salisbury | Add floating wetlands |
| RRI_17D | Centre at Salisbury Mall | Salisbury | Tree planting |
| RRI_101C | Pepboys Parking Lot at 1628 N. Salisbury Blvd. | Salisbury | Remove remainder of pavement between bioretentions |
| RRI_24B | Delmarva Evangelistic Church, E. Gordy Dr. | County | Tree planting - south of baseball diamond and east of pond |
| RRI_52A | Heather Glen Dr. Stormwater Pond | County | Fountain or Proprietary water control practice |
| RRI_52C | Heather Glen Dr. Stormwater Pond | County | Floating Wetlands in wet ponds to increase nutrient removal |
| RRI_3A | Priscilla Street and Hammond Street | Salisbury | Add floating wetlands |

*Neighborhood Source Assessment*

A total of 35 neighborhoods were visited by the field crews. A list of the assessed neighborhoods can be found in Appendix G. Approximately 1,942 acres of neighborhoods were assessed using the NSA protocol. Sixty-three percent (1,221 acres) of area had no apparent stormwater treatment. Thirty percent (~400 acres) of that is in impervious cover, representing a significant area of uncontrolled stormwater. Average impervious cover per lot across all neighborhoods was ~40%. Average forest canopy observed in all of the neighborhoods was 19%. Most downspouts (~90%)

drained to pervious surfaces so downspout disconnection is not a priority; however, rain gardens were identified as feasible in six neighborhoods.

Less opportunity for projects was observed north of the Rt. 13 beltway. Neighborhoods in this area included newer development with small lots, trailer parks, and older, established neighborhoods with good tree canopy. No neighborhoods were identified as having high restoration potential; those neighborhoods categorized as moderate for restoration potential were closer to downtown and inside the Rt. 13 beltway. These neighborhoods had opportunities for tree planting, lawn management, leaf pick-up, rain barrels and rain gardens. Representative neighborhood photos can be found in Figures 4.21 – 4.22 and high priority neighborhoods are displayed in Table 4.26.

**(a) (b) (c)**

**Figure 4.21. (a) High pollution severity as evidenced by a highly managed lawn at NP_NSA_19a; (b) Stormwater pond at NP_NSA_20 with opportunity for vegetated buffer, pond retrofit and floating wetlands to improve water quality; and (c) Opportunity for rain gardens at NP_NSA_19b.**

**(a) (b) (c)**

**Figure 4.22. (a) Highly manicured lawn at NP_NSA_21 with high pollution severity and little available space for restoration; (b) Lots with little tree canopy at NP_NSA_8; and (c) Stormwater pond mowed to edge at NP_NSA_10.**

| Table 4.26. Neighborhood Source Control Opportunities in the North Prong Subwatershed | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Site_ID** | **Location** | **Jurisdiction** | **Pollution Severity** | **Restoration Potential** | **Opportunity** | **Cost** | **Priority** |
| NP_NSA_15 | Zion Rd, Bennett Rd, and Cannon Dr | County | High | Moderate | Better lawn/landscaping practice. Tree planting, rain barrels, leaf pickup, and lawn education. | $ | High |
| NP_NSA_16 | Runaway Bay Apartments | Salisbury | Moderate | Moderate | Better lawn/landscaping practice. Reduce mowing around stormwater pond. | $ | High |
| NP_NSA_18 | Cherry Way, Chestnut Way, Maple Way, and Cedar Way | County | Moderate | Moderate | Better lawn/landscaping practice. Leaf/lawn maintenance, tree planting, junk/yard clean-up. | $ | High |
| NP_NSA_19A | Heather Glen | County | High | Low | Better lawn/landscaping practice. Better management of common space, pond retrofit, pool education, tree planting. | $$$ | High |
| NP_NSA_19C | Sherwood Circle | County | Moderate | Moderate | Rain barrels, downspout disconnection. | $ | High |
| NP_NSA_19D | Parkhurst Manor | County | Moderate | Low | Tree planting, rain barrels, septic maintenance, downspout disconnection, leaf management | $ | High |
| NP_NSA_20 | Nottingham Woods | County | High | Moderate | Better lawn/landscape practice; pond retrofit. Lawn management, pond retrofit, septic maintenance. | $ | High |
| NP_NSA_21 | The Preserve (Stream Valley Ct.) | Salisbury | Moderate | Low | Onsite retrofit potential; better lawn/landscaping practice; better management of common space. Tree planting, rain barrels, downspout disconnection, lawn management, potential for small rain gardens. | $ | High |

**Table 4.26. Neighborhood Source Control Opportunities in the North Prong Subwatershed**

| Site_ID | Location | Jurisdiction | Pollution Severity | Restoration Potential | Opportunity | Cost | Priority |
|---|---|---|---|---|---|---|---|
| NP_NSA_22 | East Village | County | Moderate | Moderate | Better lawn/landscaping practice; pond retrofit. Tree planting, rain barrels, septic maintenance. | $$ | High |
| NP_NSA_40 | Hearn Ln, Bailey Ln, and Sarah Ln | County | Moderate | Moderate | Better lawn/landscaping practice. Tree planting, leaf removal, septic maintenance. | $$ | High |
| NP_NSA_2 | Bridgewood Estates | Delmar | Low | Low | Storm drain stenciling, tree planting. | $ | High |
| NP_NSA_7 | Lynch Drive, Lennos Drive, Wood Creek Parkway | Delmar | Low | Moderate | Storm drain stenciling, tree planting, pond maintenance/redesign. | $ | High |

$: Estimated Planning Level Cost < $5,000
$$: Estimated Planning Level Cost $5,000-$20,000
$$$: Estimated Planning Level Cost > $20,000

*Hotspot Site Investigation*

A total of 29 hotspot sites were assessed in the North Prong subwatershed. One site was identified as a severe hotspot, four sites were identified as confirmed hotspots, four sites were identified as potential hotspots, and twenty sites were not a hotspot. Pollution producing behaviors that were noted were primarily related to vehicle operations, storage of outdoor materials, and waste management. The hotspot assessment was conducted from public streets or parking areas; site access was not always obtained. For sites identified as severe or confirmed, a follow-up assessment should be completed on-site with the owner to determine exact activities and operations occurring on the site. Some of these sites may also require an individual NPDES permit with the State and this should be ascertained. Three high priority hotspots were identified throughout the subwatershed (Table 4.27). A full list of hotspot opportunities identified in the Tiber Hudson can be found in Appendix G.

Severe and confirmed hotspot sites included the following:

- HSI_30, Signs by Tomorrow and Line X, SE corner of Alexander Dr. and Northwood Dr. (Figure 4.23): 55-gallon unlabeled drums stored outside with no cover or containment, some on their side. Raw materials stored outside without cover. Trash strewn about the site. Site is adjacent to Peggy Branch.
- HSI_10, Mr. Pauls, 1801 N. Salisbury Blvd and Boulevard Motors, 1815 N. Salisbury Blvd. (Figure 4.24): Multiple pollution sources from a used oil container, 50 gallon containers with no labels and lids askew, staining on parking lot and sediment on edge of lot contaminated with oil, grease, etc. Retrofit proposed (RRI 402).
- HSI_14, Sherwood of Salisbury, 1902 N. Salisbury Blvd. (Figure 4.25a): Outdoor washing of vehicles with washwater draining to impervious surface.
- HSI_15a, Pohanka of Salisbury, 2011 N. Salisbury Blvd. (Figure 4.25b): Outdoor washing of vehicles with washwater draining to impervious surface.
- HSI_31, Jubilant Cadista, Kiley Dr. (Figure 4.26): Poor erosion and sediment control practices.

**(a)** **(b)**

**Figure 4.23. HSI_30 (a) 55-gallon unlabeled drums, rusting and knocked over at Line X and (b) Raw materials and trash strewn about behind the commercial property at the southeast corner of Northwood Drive and Alexander Avenue.**

**(a)** **(b)**

**Figure 4.24. HSI_10 (a) Restaurant grease container at Mr. Pauls, open with stains all around and (b) Chemicals in unlabeled containers outside without cover or containment at Boulevard Motors.**

**(a)** **(b)**

**Figure 4.25. Outdoor vehicle washing at (a) Sherwood of Salisbury (HSI_14) and (b) Pohanka of Salisbury (HSI_15a).**


**(a)** **(b)**

**Figure 4.26. HSI_31 (a) and (b) Poor erosion and sediment control (ESC) practices at Jubilant Cadista.**

Potential hotspot sites included the following:

- HSI_5, Hunan Delight, 901 N. Salisbury Blvd (Figure 4.27a): Staining on lot to storm drain from mop water dumping.
- HSI_12, Perdue plant (Figure 4.27b): Site could not accessed. Large piles of grain stored outside but drainage uncertain.


**(a)** **(b)**

**Figure 4.27. (a) Staining on parking lot leading to storm drain at Hunan Delight (HSI_5) and (b) Raw materials stored outside without cover at the Perdue plant (HSI_12)**.

**Table 4.27 Priority Hotspot Sites in the North Prong Subwatershed**

| Site ID | Location | Jurisdiction | Type of Hotspot | Description | Status | Recommended Actions | Cost | Priority |
|---|---|---|---|---|---|---|---|---|
| HSI_5 | Hunan Delight at 901-J North Salisbury Blvd. | Salisbury | Outdoor Materials Storage | Restaurant - grease storage and bucket dumping (mop water leaving staining headed to storm drain) | Potential | Outreach to property owner | $ | High |
| HSI_11A | Salisbury Commercial Warehousing Complex, 300 Moss Hill Ln | County | Vehicle Operations, Outdoor Material Storage, Turf/Landscaping Areas, Stormwater Infrastructure | Trucking/warehousing | Potential | Canopy. | $ | High |
| HSI_11B | Milford Twilley Rental Management, Harrison Street and Craft Street | County | Vehicle Operations, Outdoor Material Storage, Waste Management, Turf/Landscaping Areas | Rental equipment | Potential | Canopy. | $ | High |
| HSI_12 | Perdue Plant | County | Vehicle Operations, Outdoor Material Storage, Turf/Landscaping Areas, Stormwater Infrastructure | Poultry processing plant | Potential | Site inspection to determine more information. | $ | Medium |
| HSI_10 | Mr. Pauls 1801 N Salisbury Blvd Boulevard Motors, 1815 N Salisbury Blvd | Salisbury | Outdoor Materials Storage, Waste Management | Banquet Hall, Car sales | Confirmed | Site inspection. Cover and absorbent for grease container. Storage shed for chemicals. | $$ | Medium |
| HSI_14 | Sherwood of Salisbury, 1902 N. Salisbury Blvd | County | Vehicle Operations, Outdoor Materials | Car dealership | Confirmed | Site inspection. Containment mat for washing. Secondary containment for oil | $$ | Medium |
| HSI_30 | SE corner of Alexander Dr and Northwood Dr | Salisbury | Outdoor Material Storage, Waste Management | Signs by Tomorrow, Line X | Severe | Site inspection. Canopy. | $ | Medium |

$: Estimated Planning Level Cost < $5,000
$$: Estimated Planning Level Cost $5,000-$10,000
$$$: Estimated Planning Level Cost > $10,000

*Unified Stream Assessment*

Twenty-two stream reaches were initially identified in the North Prong subwatershed through a desktop assessment. Several of these "stream reaches" e.g., Johnson Pond, Williams Mill Pond, etc. are actually impoundments and the stream reach assessment form is not applicable to these types of systems. Therefore, a stream reach form was not completed; however, impacts to the ponds from the surrounding watershed were assessed to the extent possible. Due to the limited amount of time available to conduct the stream assessments plus limited access on private property, field crews primarily assessed streams from road crossings or by walking a short section of stream where public property access was available.

Three reaches that were assessed had no observable baseflow. These reaches were all in the headwaters and were marked as blue line streams in the GIS system.

An overall quantitative score for each reach was assigned based on average physical condition of various in-stream and riparian parameters (i.e. diversity of instream habitat, floodplain connectivity, vegetative buffer width, etc.). These scores were used to classify stream reaches into condition categories ranging from *excellent* to *very poor* (Table 4.28, Figure 4.28).

The best reach score in the study area was NP_RCH101a, which scored 155 points. This can be considered a representative score for the best attainable condition for a reach within the watershed. A score of at least 89% or greater than this number (≥138) is considered comparable to the reference condition and represents excellent stream conditions for the watershed. A score less than 19% (≤70 pts) of the reference score is considered very poor. Between these two end points, 46% of the reference score (109≥71 pts) represents poor stream conditions, 71% of the reference score (125≥110 pts) represents fair stream conditions, and 81% of the reference score (137≥126 pts) represents good stream conditions.

**Table 4. 88. Stream Reach Scoring Criteria**

| Classification | Percentile | Point Threshold |
|---|---|---|
| Excellent | 89% | ≥138 |
| Good | 81% | 126 ≥137 |
| Fair | 71% | 110 ≥125 |
| Poor | 46% | 71 ≥ 109 |
| Very Poor | 19% | ≤ 70 |

While these criteria serve to place the assessed reaches in context, they are somewhat subjective. A reach scoring a few points higher than another may be placed in a higher category, but the qualitative aspects of the method make differences of a few points insignificant. Maps of the stream reaches assessed and the observed impacts can be found in Appendix D.

**(b)** **(b)**

**Figure 4. 28. (a) RCH 101a - "excellent reach" with wide, forested buffer and good floodplain connectivity and (b) RCH 104 - "very poor" reach in the headwaters modified as a drainage ditch.**

A total of 19 stream reaches were assessed in the North Prong subwatershed. Seven reaches (37%) were assessed as excellent, two (11%) were assessed as good, six (32%) were assessed as fair, two (11%) were assessed as poor and two (11%) were assessed as very poor. Stream reaches scoring low were modified as drainage ditches in agricultural fields, had excessive trash, limited or no buffer and/ or prevalent invasive species. Stream reaches scoring higher had favorable habitat conditions, large, intact buffers, and wetland habitat and river access to the floodplain. Many high quality streams were observed

A summary of notable restoration opportunities and stream impacts observed in the stream reaches are presented in Table 4. 1 with several representative photos in Figure 4.29. A complete list of the stream reaches assessed and the stream impacts observed can be found in Appendix G. Five high priority and seven medium priority opportunities to restore the riparian corridor in the North Prong subwatershed were identified. Specific techniques prescribed to these locations include trash clean up, buffer planting, and invasive plant removal.

**Table 4.29. Stream Impacts in the North Prong Subwatershed**

| Site ID | Location | Impact | Estimated Cost to Restore | Priority |
|---|---|---|---|---|
| NPIB_105_1 | North of Connelly Mill Rd and east of Wood Creek Pkwy | Buffer | $1,322.31 | High |
| NPIB105_2 | Near Foskey Rd and Bi State Blvd | Buffer | $464.65 | High |
| NPIB104_1 | North and south of Haney's Branch Rd, west of Foskey Ln | Buffer | $1,677.69 | High |
| NPIB204_1 | East of Northwood to Rt 13 | Buffer | $285.58 | High |
| NPTR101a_1 | Gordy Mil Rd, east of Stage Rd | Trash | $100.00 | High |
| NPTR106_1 | Delmar, south of Line Rd | Trash | $100.00 | High |
| NPTR204_2 | Next to Pep Boys on south side | Trash | $100.00 | High |
| NPIB_106_1 | Delmar, north and south of Line Rd | Buffer | $2,465.56 | Medium |

| Table 4.29. Stream Impacts in the North Prong Subwatershed | | | | |
|---|---|---|---|---|
| **Site ID** | **Location** | **Impact** | **Estimated Cost to Restore** | **Priority** |
| NPIB_101_1 | North of Adkins Rd | Buffer | $2,035.81 | Medium |
| NPTR113a_1 | Zion Rd just west of Rt 13 | Trash | $100.00 | Medium |
| NPTR304_1 | Near Johnson's Pond dam in City municipal yard | Trash | $100.00 | Medium |
| NPTR204_1 | West of Northwood Rd | Trash | $100.00 | Medium |
| $: Estimated Planning Level Cost < $2,000<br>$$: Estimated Planning Level Cost $2,000-$8,000<br>$$$: Estimated Planning Level Cost > $8,000 | | | | |

(b) (b)

(c)

**Figure 4. 29. (a) Headwater stream modified as tax ditch (IB105_2); (b) impervious lot to edge of stream (IB204_1); (c) Trash accumulation at TR113a_1; and (d) Dumping at TR304_1.**

Twelve stream restoration opportunities were identified (Table 4. 2). Numerous opportunities for buffer planting, trash clean-ups, and stream crossings with varying degrees of failure or potential failure were identified. Invasive species were noted throughout the subwatershed, including English ivy, mimosa, Japanese knotweed, ailanthus, and phragmites. Of these species, English ivy removal would have the greatest benefit as there is opportunity to save entire trees with relatively little effort. Japanese knotweed appears to be becoming more prevalent throughout the watershed and, because of its difficulty to control and ability to propagate downstream from small pieces, it is worth trying to manage, particularly as it relates to urban tree canopy goals for the area.

**Table 4. 30 Summary of Noted Stream Improvement Opportunities and Impacts**

| Impact Type | Site Description |
|---|---|
| Stream Buffer Restoration | • Impacted buffer identified along 6,048 linear feet of stream (1.15 miles)<br>• Invasive species impacting buffer (NPIB_105_1, NPIB204_1)<br>• Stream modified into a tax ditch and mowed to edge (NPIB105_2, NPIB104_1, NPIB_106_1, NPIB_101_1) |
| Trash | • Several locations where trash can easily be picked up by volunteers (NPTR101a_1, NPTR106_1, NPTR204_2, NPTR304_1)<br>• One location with moderately difficult access (NPTR113a_1) |
| Stream Crossing | • Erosion and scour noted around crossings (NPSC101a_1, NPSC106_2, NPSC107_1)<br>• Partial blockage of culverts (NPSC204_1)<br>• Failure of newly installed rip rap (NPSC304_1) |
| Utility | • Exposed sewer line crossing stream with some pipe corrosion and cracking noted (NPUT301_1) |

*4.4.3. North Prong Protection Strategy*

Using the process identified in Section 4.1.5, several high priority areas for protection were identified that support important ecological areas and sensitive species (Figure 4. 19). GIS was used to identify the acres of protection area that are not currently protected via the State, municipalities, easements, or other means. This analysis identified 2,153 acres (8.7% of the watershed) of high priority area to be protected and 5,783 acres (23.3% of the watershed) of priority area to be protected.

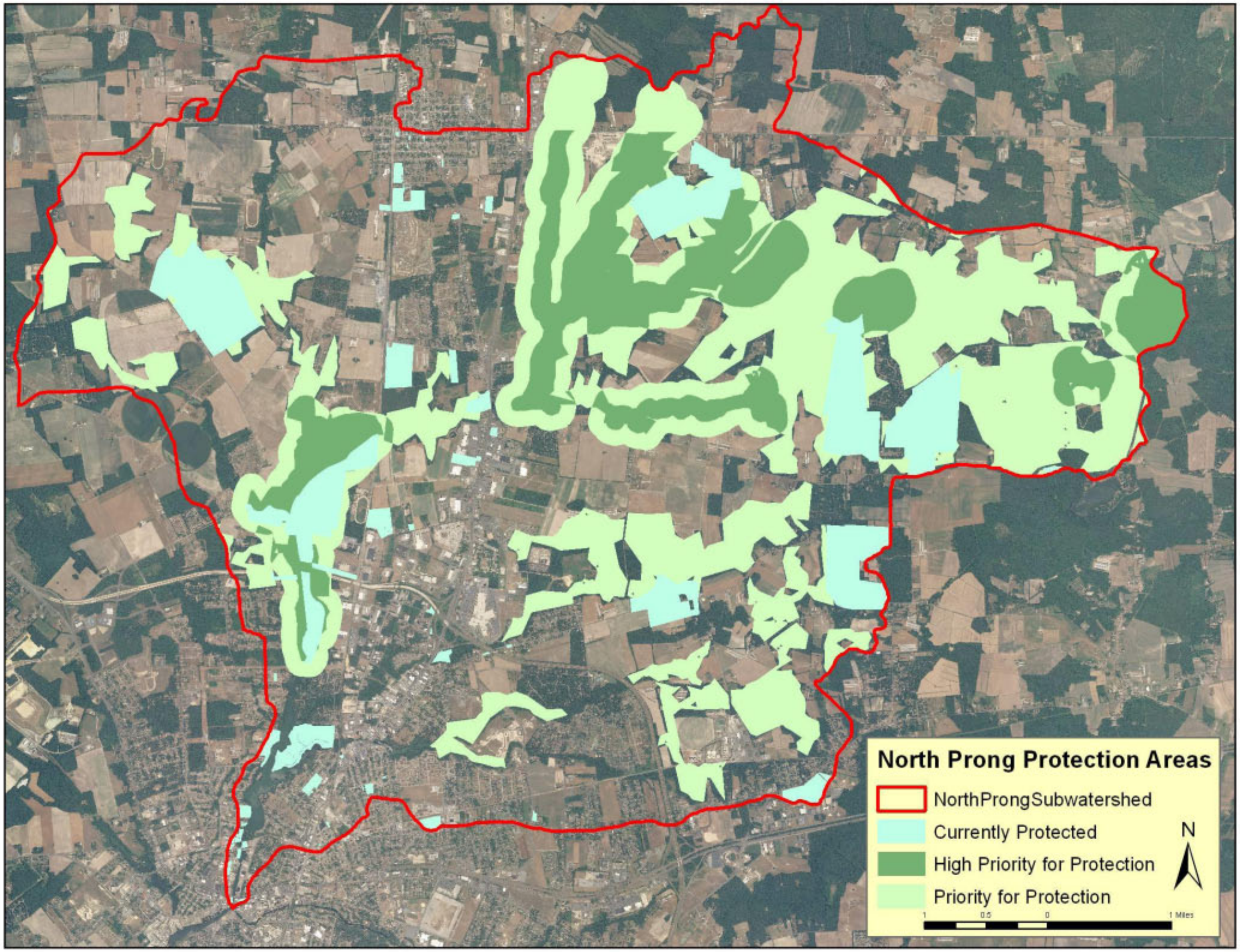



**Figure 4. 30. Priority areas for protection in the North Prong subwatershed.**

# SECTION 5. ACTION PLAN

## *5.1. Watershed Restoration Action Strategies*

A watershed vision, goals and objectives guide this plan. Based on these watershed objectives and the results of the watershed characterization assessment and field findings, eleven key strategies were developed that are presented in order of implementation priority. These strategies focus on a range of activities from municipal practices and programs, natural resources protection, the treatment of polluted runoff, and source control and education. Watershed restoration strategies for the South Prong, Tony Tank and North Prong Subwatersheds are presented below:

1. *Transition the Core Team into a long term management structure*.

During the planning process, the Core Team served as a means of providing input into the watershed planning process that includes input on goals, objectives, assessing watershed conditions and determining watershed priorities. As the focus moves towards implementation, the Core Team should shift towards a role of long term implementation of the plan. As a group, the Core Team should encourage formal adoption of the watershed plan by each jurisdiction. In addition, the Core Team should consider hiring a full-time staff person who would oversee implementation of the plan. This staff person would most likely be employed by Wicomico County, the Wicomico Environmental Trust or the City of Salisbury, as determined most appropriate by the Core Team and hosting agency/organization.

2. *Prevent further degradation in the subwatersheds by implementing protection efforts.*

Priority protection areas were identified through a desktop assessment and field checked with stream assessments. To prevent further degradation of the subwatersheds and downstream water quality, it is important that these areas remain protected from development and urban/suburban encroachment. These priority areas were identified due to the presence of important ecological areas that support sensitive species and their location near existing protected areas. The Lower Shore Land Trust (LSLT) is a local organization that works with landowners to identify the best means to protect properties and can be contacted to assist in protection of these priority areas. Three high priority areas of currently unprotected land were identified for protection in the South Prong (1,211 acres), several high priority areas in the Tony Tank (1,305 acres) and in the North Prong (2,153 acres). Protecting these areas will help to maintain connectivity and important ecological "hubs" such as the Nassawango Creek preserve owned by The Nature Conservancy, Pemberton Park and large tracts of forest in the eastern North Prong. For agricultural preservation efforts, the County should become re-certified with the Maryland Agricultural Land Preservation Foundation.

The County and City should consider passing a 100 foot stream buffer regulation to protect the existing intact stream buffers on both intermittent and perennial streams. Currently only a 50 foot stream buffer on blue line perennial streams is provided through a level of review under the Forest Conservation Act. Stream buffers function to reduce the impacts from land development including stabilizing banks, providing organic matter for aquatic life, filtering nutrients, providing habitat and attenuating flood water (Wenger, 1999).

The Wicomico Watershed is located in the critical sea level rise area as identified in the Maryland Sea Level rise plan. Wicomico County has 34.3 square miles of vulnerable land and Somerset has 126.8 square miles (Nuckols et al., 2010). Two-foot and two-to-five inundation levels were reviewed for this study. Two-foot inundations were negligible for the South Prong and indicated 7 acres for Tony Tank. Two-to-five foot inundations indicated 24 acres of inundation for the South Prong, 166 acres for Tony Tank and 36.8 acres for the North Prong To mitigate these effects, a large amount of wetland and stream buffers should be protected as they will recede inland gradually as the sea level rises.

3. *Implement pollution prevention measures at municipal and private sites, including employee training.*

During the hotspot assessment, seventy-three hotspot sites were assessed in the subwatersheds. Eight sites were identified as severe hotspots, 17 as confirmed hotspots and seven as potential hotspots. Stormwater pollution prevention plans should be reviewed, enforced and updated at severe sites. Some hotspot sites were municipal sites and employee training should be conducted to ensure compliance with the MS4 permit. The City should also review the illicit discharge ordinance to ensure adequate enforcement measures are in place for staff. Pollution prevention education should be conducted at hotspot sites to focus on: municipal pollution prevention and good housekeeping procedures, outdoor commercial vehicle washing, storage of outdoor materials, lack of secondary containment, leaking dumpsters and the zoo exhibit that has direct interaction with the water. Appendices E-G identify the hotspot locations.

4. *Encourage pollution prevention practices as well as tree planting and landscape management in residential neighborhoods.*

Stormdrain inlet marking or stenciling was noted as absent in the majority of neighborhoods. In addition, organic matter and sediment was observed in the street and storm drain network in several neighborhoods. Opportunities exist in neighborhoods to educate homeowners on removing debris from roadways. In addition, the City and County should consider increasing the frequency of leaf pick up and street sweeping, which is a TMDL creditable practice depending on the frequency[11]. Highly fertilized lawns were mainly identified in the multifamily neighborhoods. Education should be provided to the maintenance company on proper lawn fertilization. In addition, very little tree canopy was observed in several neighborhoods presenting an opportunity for increased tree plantings, which would also align with urban tree canopy goals. Appendices E-G identify high priority neighborhoods.

5. *Plant trees watershed-wide to increase tree canopy*

Trees improve water and air quality, provide recreational opportunities, wildlife habitat, strengthen local economies, and are a cost effective nutrient reduction strategy. In addition, this recommendation will assist with meeting the City of Salisbury and Wicomico County urban tree canopy goal and can be implemented in the urban tree canopy implementation plan.

[11] Street sweeping two times per month is a Chesapeake Bay TMDL creditable practice.

This strategy will help meet the tree planting goals in the current City and County Watershed Implementation Plans (WIPs) of 50,000 and 250,000 trees, respectively. Several opportunities for tree planting were identified in neighborhoods (strategy 6), schools, and along streams as buffers. Tree planting is a very cost effective restoration action that provides multiple benefits, including ecological, economic and quality of life benefits – protecting air and water quality, reducing energy costs, increasing property values and beautifying neighborhoods and highways. Altogether, 327 acres of tree planting opportunities were identified in the subwatersheds. Location of tree planting opportunities can be found in Appendices B-D.

6. *Implement high priority stormwater retrofit practices, particularly educational/demonstration projects.*

Stormwater retrofits targeting nutrient and pathogen removal are priorities. Retrofits designed to control volume and protect channels from erosive flows are also critical in the watershed. Many opportunities for providing stormwater treatment through various practices were identified in all three subwatersheds. Project locations included Parkside High School, Ward Museum, Wicomico Middle School, Prince Street School, public lots in downtown Salisbury, East Salisbury Elementary School, Water Treatment Plant at Naylor Mill Rd and Scenic Dr, the Salisbury Zoo, City Courthouse, Deer's Head Hospital, Pemberton Park, Salisbury Middle School, and municipally-owned sites and neighborhoods such as Georgia Ave Apartments, Pinebluff Village, etc. High priority retrofit projects were identified (Table 4. 4 and 4.25).

Municipal owned parks and County schools are great places for demonstration stormwater retrofit practices because of the educational component associated with the projects. There is an opportunity to incorporate stormwater and the environment into the school science curriculum that will teach students about water quality. Several opportunities were present at parks and schools to disconnect downspouts or treat rooftop runoff into a rain garden or bioretention system (Appendix E-G). The Wicomico Environmental Trust is engaging schools in environmental activities and restoration.

Staff from the City of Salisbury noted that several municipal parking lots near downtown will be redeveloped. These parking lots present stormwater management opportunities during the redevelopment process as required in the Maryland stormwater design manual.

7. *Implement priority stream improvement projects.*

A number of buffer planting, invasive plant removal of Japanese knotweed (*Fallopia japonica)*, natural channel design and discharge inspection projects were identified throughout the subwatersheds to help stabilize eroding stream channels, enhance vegetated riparian buffers, and remove polluted discharges from entering the streams. In the South Prong, 18,057 linear feet of impacted buffer, 5,987 linear feet of channel modification, 54 linear feet of erosion and one illicit discharges to investigate. In the Tony Tank, 30,866 linear feet of impacted buffer, 342 linear feet of channel modification, 202 linear feet of erosion, and three illicit discharges to investigate. In the North Prong, 6,048 linear feet of impacted buffer, 230 linear feet of channel modification and 70 linear feet of erosion.

Buffer planting and invasive plant species management projects (knotweed and Phragmites) require planning prior to implementation and stream repair projects will require additional design work and potential coordination with upstream retrofits. Due to the prevalence of invasive plants throughout the watershed, integrating their management with priority buffer reforestation projects will be critical to success. In addition, a feasibility study for a large water quality demonstration project is recommended to determine the most effective options at SP_SC301, located west of the zoo on the mainstem of the South Prong. This location is very visible, providing for ample education opportunities, and has the potential to treat a portion of the entire South Prong subwatershed. Priority stream projects are identified in Tables 4.12, 4.21, and 4.29 and Appendices E-G.

Living shorelines are a natural bank stabilization technique that utilize a variety of structural and organic materials, such as wetland plants, submerged aquatic vegetation, oyster reefs, coir fiber logs, sand fill and stone. They provide multiple benefits such as stabilization, habitat, protection and filtering of upland runoff. Many opportunities for implementing living shorelines were apparent along the lakes as well as along the Wicomico River mainstem such as at the Cherry Hill development (TTIB48_1).

*8. Investigate strategies for pond management*

Fifteen impoundments were identified in the subwatersheds, five in the South Prong and four in Tony Tank and six in the North Prong[12]. Some of the more prominent ponds in the subwatersheds include Parker Pond, Schumaker Pond, Tony Tank Lake, Colbourne Mill Pond, Johnson's Pond, Leonard Mill Pond, among others. The ponds exhibit eutrophication most likely from phosphorus loading from failing septics, geese and stormwater runoff. The ponds are typically dominated by aquatic weeds due to the shallow depth. Further investigation should be conducted on the ecological factors that sustain and reinforce dense populations of aquatic weeds. Efforts for pond management should be coordinated with septic efforts (Strategy 10). Several pond management approaches are outlined in Section 4.1.3.

*9. Minimize the creation of impervious surfaces during the development review process*

The County and City subdivision and land development ordinances dictate the creation of impervious surfaces and the protection of natural resources during the development process. The County and City should provide a review of their development codes and ordinances to encourage the use of innovative stormwater management practices (e.g. cisterns, bioretention), reduce the amount of impervious cover created (e.g. parking lot requirements) and protect natural resources (e.g. require tree protection standards). This review can be accomplished using the Code and Ordinance Worksheet available for free at www.cwp.org (CWP, 1998).

*10. Educate homeowners regarding advanced nutrient removal septic systems and connect failing septic systems to the sewer system as per the County's Water and Sewerage Plan (2010).*

Although, septic systems were not assessed as part of this study, according to the MAST, there are approximately 23,200 individual on-site sewerage disposal systems (OSDSs) within the

[12] More impoundments are visible from aerial photography but were not assessed in the field.

County systems. Septic systems are problematic as they do not provide adequate removal of nitrogen and are often not properly maintained or pumped out. The County currently uses Bay Restoration Funds to upgrade ~50 OSDSs per year to the best available technology that provides enhanced nitrogen removal. This program should be continued, and increased if additional funding is made available through the State. Proper maintenance of septic systems, particularly pumping every 3-5 years, can result in water quality benefits. Finally, failing septic systems should be connected to the sewer system where possible to be treated at the wastewater treatment plant.

*11. Track and monitor the implementation progress*

The Core Team should develop an approach to monitoring implementation activities that includes project monitoring, sentinel station monitoring, and project tracking.
Project monitoring should be geared towards quantitative measures of success for both structural and non-structural management and restoration practices (i.e., stormwater retrofits, stream repair projects, etc.). Monitoring methods will depend upon the project, but can involve pre and post biological sampling and cross sections at stream repair projects, and simple accounting of disconnections performed as part of a discharge prevention program.

Continued monitoring through the Creekwatchers program should continue at existing stations throughout the watershed to investigate water quality conditions, the impact of potential barriers on in-stream biology, and long term trends. Trend monitoring is the best way to determine if stream conditions are improving, watershed goals are being met, and progress towards meeting regulatory requirements is being made.

Managing the delivery of a large group of restoration projects within the watershed can be a complex enterprise. Therefore, it is a good idea to create a master project spreadsheet linked to a GIS system that tracks the status of individual projects through final design, permitting, construction, inspection, maintenance and performance monitoring. By tracking the delivery of restoration projects, lessons learned can be identified and implementation progress over time can be assessed, which in turn, helps explain future changes in water resource quality.
Project tracking can also improve the delivery of future projects, and creates reports that can document implementation progress for key funders and stakeholders. The tracking system should account for all restoration practices undertaken in the watershed regardless of their type or size. The Core Team should determine a central entity for coordinating overall implementation; this will be linked to Strategy 1.

## *5.2 Implementation Planning and Costs*

Implementation is by far the longest and most expensive step in the watershed management process. In fact, restoration and protection costs for a single suburban subwatershed can easily range in the million dollars depending on the extent of restoration and protection activities, number of jurisdictions involved, land costs, and other factors. Salaries, land acquisition and construction of projects often account for a majority of these costs. A minimum of twenty years is usually needed to design and construct all the necessary projects, which are normally handled in several annual “batches.” Sustaining progress over time and adopting the plan as more experience is gained are vital aspects of implementation.

Presented below are planning partners, planning level costs, and phasing and resources for implementing watershed strategies. Table 5. 1 provides the goals and objectives met and interim milestones for implementation of each strategy. Table 5.2 provides a draft implementation schedule and associated costs for implementing each short term, mid-term and long term actions. Table 5.3 identifies the implementation parties and roles and capacity best suited for each party as identified at Core Team meeting 3. It should be noted that although the matrix indicates that Salisbury, Fruitland and the County have the capacity for much of the project contract administration, they have limited staff resources available. In addition, to date there is an overall lack of resources available by the partners to fully implement the plan. Final determination of responsible parties for each strategy should be a discussion item at future Core Team meetings.

The cumulative estimate for implementing the 11 strategies is approximately $2.2 million dollars over the short and mid-term (Table 5.2). The largest component of these cost results from the estimated cost of acquiring conservation easements (Strategy 2) and implementing stormwater retrofit and stream projects (Strategy 6 & 7). Additional costs are associated with hiring a watershed coordinator and implementing pollution prevention measures and municipal and private sites. Costs associated with watershed strategy 2 alone are estimated at over $1.1 million dollars for the mid-term, which assume costs for conservation easements on 467 acres of land and will require the County to become re-certified with the state for the preservation of agricultural land.

Project costs represent only planning level estimates and were determined based on guidance provided in Schueler et al. (2007), Wright et al. (2005), Kitchell and Schueler (2004), King and Hagan (2011) and personal communication with Kate Patton of the Lower Shore Land Trust. These estimates should be adapted to include more appropriate local cost estimates where available. These cost estimates should be used to guide the County, the City, and other project partners in estimating annual operation and implementation budgets for the South Prong, Tony Tank and North Prong subwatersheds. The implementation costs should be distributed across implementation partners, existing programs, and responsible property owners (i.e., the County, City, institutions, businesses, and landowners). Project costs and cost ranges associated with over 170 individual watershed projects and 82 neighborhoods can be found in Appendices E-G. Some individual projects from these lists are incorporated into the implementation plan as examples. Project partners should consult the appendices to begin implementation of high priority projects and factor costs from the most feasible projects into the overall implementation strategy.

**Table 5. 1. Wicomico River Restoration Implementation Strategy**

| Goals Met | Objectives Met | Strategy | Interim Milestones |
|---|---|---|---|
| All | All | 1. Transition the Core Team into a long term management structure | • Each jurisdiction to formally adopt the plan<br>• Hire a watershed coordinator<br>• Meet monthly to discuss progress on strategies |
| 1<br>2<br>3 | 1, 2<br>1-4<br>2, 3, 5 | 2. Prevent further degradation in the subwatershed by implementing protection efforts | • Work with the LSLT to protect parcels within the identified high priority areas<br>• Establish a buffer protection ordinance<br>• Enact protection measures for buffers and wetlands that will be inundated due to sea level rise |
| 1 | 1,3,5 | 3. Implement pollution prevention measures at municipal and private sites, | • Stormwater pollution prevention plans at potential, confirmed and severe hotspot sites enacted, reviewed and/or enforced |

| Table 5. 1. Wicomico River Restoration Implementation Strategy | | | |
|---|---|---|---|
| **Goals Met** | **Objectives Met** | **Strategy** | **Interim Milestones** |
| | | including employee training. | • Pollution prevention and good housekeeping training provided to municipal employees<br>• Illicit discharge ordinance reviewed and enforcement measures established, if needed<br>• Commercial outdoor vehicle washing ceased<br>• Secondary containment provided for outdoor and waste materials<br>• Determine feasibility of moving zoo exhibits that have direct contact with the river |
| 1<br>3 | 1,3<br>4 | 4. Encourage pollution prevention practices as well as tree planting and landscape management in residential neighborhoods | • Conduct 4 homeowner education events on pollution prevention<br>• Conduct stormdrain marking in half of the neighborhoods<br>• Conduct 4 educational events on proper maintenance of lawns as well as conservation landscaping<br>• Hold 2 tree planting giveaways |
| 1<br>3<br>4 | 1,2,3<br>2,4,5<br>1,2 | 5. Plant trees watershed-wide to increase tree canopy | • Develop a plan to meet tree canopy goal (see strategy 4, 7)<br>• Plant trees along the stream where encroachment was noted |
| 1<br>3<br>4 | 1,3,6<br>1,2<br>1,2 | 6. Implement high priority stormwater retrofit practices, particularly education/demonstration projects | • Install 2 retrofit projects<br>• Install 2 projects at schools or parks |
| 1<br>3 | 1,2<br>1,2,5 | 7. Implement priority stream improvement projects | • Continue to sample for potential illicit discharges as reported in CWP, 2011<br>• Implement feasibility study SP_SC301<br>• Implement top 2 projects |
| 1<br>4 | 4<br>4 | 8. Investigate strategies for pond management | • Study the ecological factors that sustain and reinforce dense populations of aquatic weeds in priority ponds<br>• Encourage the implementation of strategies to reduce nutrient inputs to the ponds (strategy 10) |
| 1 | 5,6 | 9. Minimize the creation of impervious surfaces during the development review process | • Review the City and County development codes using the Codes and Ordinances Worksheet (CWP, 1998) |
| 1<br>4 | 1,3<br>1 | 10. Educate homeowners regarding advanced nutrient removal septic systems and connect failing septic systems to the sewer system as per the County's Water and Sewerage Plan (2010). | • Provide septic maintenance workshops around ponds / lakes with dense weeds and eutrophication<br>• Lobby state for additional BRF funds |
| All | All | 11. Track and monitor the implementation progress | • Continue to analyze Creekwatcher data to show annual trends.<br>• Provide an annual report on the state of the river. |

**Table 5.2. Implementation Actions and Costs***

| Strategy | Short-Term Action (year 1) | Mid-Term Action (year 2-4)[1] | Long-Term Action (year 5+)[2] |
|---|---|---|---|
| 1. Transition the Core Team into a long term management structure | Assign responsible parties for each restoration strategy using this table as well as the projects identified in the Appendices. (20 hrs) | Find funding for support of Watershed Coordinator staff position (80 hrs =$2,400). | Develop long-term work plan for Watershed Coordinator |
| | Determine most logical entity to host a Watershed Coordinator staff position (20 hrs ) | Hire Watershed Coordinator ($35,000/yr/3 yrs) | Ensure that Coordinator actions are effectively directed to meet water quality and watershed restoration goals, which may change over time |
| | Determine specific roles and responsibilities for Watershed Coordinator (20 hrs ) | | Annual salary for Watershed coordinator |
| Strategy 1 Costs | $3,300 | $109,400 | $$$ |
| 2. Prevent further degradation in the subwatershed by implementing protection efforts | Consider passing a 100 foot stream buffer regulation for perennial, intermittent and ephemeral streams (200 hrs) | Adjust restoration and protection planning efforts to account for wetland and buffer migration (100 hrs). | Conduct outreach to landowners of high priority protection areas |
| | Promote the County's Rural Legacy program through outreach and education to landowners, which can support conservation easements on forested and agricultural parcels (100 hrs) | Conduct outreach to landowners of high priority protection areas (200hr/yr/3 yrs) | Protect 50% of remaining high priority protection areas (2,101 total acres) and 10% of priority protection areas (981 total acres)[3]. |
| | Promote sustainable management of forests through outreach and education to landowners (100 hrs) | Protect 10% of high priority protection areas (467 total acres)[3] | |
| | County to become re-certified with the MALPH program (40 hours) | | |
| Strategy 2 Costs | $24,200 | $1,109,834 | $$$$ |
| 3. Implement pollution prevention measures at municipal and private sites, including employee training. | Conduct a full hotspot assessment of all municipal facilities (5 days for field work, 3 days to post process) | Provide education on pollution prevention to targeted businesses and implement stormwater retrofits and pollution source control measures (4 trainings/yr at 32 hrs/training/3 yrs) | Develop a *Business Stewardship Outreach Program* that engages the business community in watershed restoration |

**Table 5.2. Implementation Actions and Costs***

| Strategy | Short-Term Action (year 1) | Mid-Term Action (year 2-4)[1] | Long-Term Action (year 5+)[2] |
|---|---|---|---|
| | Provide internal employee training to municipal employees regarding pollution prevention and good housekeeping practices (4 trainings/yr at 32 hrs/training) | Continue to provide employee training to municipal employees regarding pollution prevention and good housekeeping practices (2 trainings/yr at 15 hrs/training/3 yrs) | Implement BMPs on private facilities (TT_RRI_31, TT_RRI100c, SP_RRI_101, NP_RRI_17a-c) |
| | Ensure that an enforceable stormwater ordinance for preventing illicit discharges to the storm drain system is in place (320 hrs) | Implement 3 innovative BMPs on municipal properties as demonstration of good stewardship to the community (TT_RRI_55, SP_RRI_1 & NP_RRI19a) | |
| Strategy 3 Costs | $28,160 | $308,070 | $$ |
| 4. Encourage pollution prevention practices as well as tree planting and landscape management in residential neighborhoods | Identify neighborhood leaders for community stewardship (12 hrs) | Expand the storm drain marking program into older neighborhood (6 trainings at 32 hrs/3 yrs) | Increase neighborhood tree canopy and encourage natural buffer regeneration at residences along stream corridors |
| | Develop educational materials for pollution prevention and source control (40 hrs) | Disconnect residential downspouts to allow for treatment and volume reduction of rooftop runoff (100 downspouts @ $50/downspout) | |
| | Encourage tree planting and landscape management in residential neighborhoods (40 hrs + 100 trees at $19/tree) | Develop a targeted residential education program to encompass the proper application of fertilizer and use of alternatives to grass lawns, trash education and promotion of recycling, stream buffer education and conservation landscaping (3/4 FTE staff person) | |
| | | Assess ditch restoration opportunities in neighborhoods as strategy to meet water quality goals (100 hrs) | |
| Strategy 4 Costs | $6,960 | $63,680 | $$ |
| 5. Plant trees watershed-wide to increase tree canopy | Determine responsible entities for implementing and maintaining tree planting projects (20 hours) | Establish a means of supporting community groups and schools to implement their own tree planting | Assess status of meeting urban tree planting goals and revise implementation as needed |

| Table 5.2. Implementation Actions and Costs* | | | |
|---|---|---|---|
| **Strategy** | **Short-Term Action (year 1)** | **Mid-Term Action (year 2-4)**[1] | **Long-Term Action (year 5+)**[2] |
| | Align tree planting projects identified in plan with urban tree canopy goals (20 hours) | projects, including guidance on maintenance (60 hrs) | |
| | Install some tree planting demonstration projects in highly visible areas (40 hrs each + 100 trees total) | Plant 10% of identified tree planting projects (32 acres @ 100 trees/acre @ $19/tree) | Plant 60% of remaining tree planting projects |
| Strategy 5 Costs | $6,300 | $64,100 | $$$ |
| 6. Implement high priority stormwater retrofit practices, particularly educational / demonstration stormwater retrofit practices | Identify funding sources for retrofits (80 hrs) | Install educational/demonstration stormwater retrofit projects at schools and parks (SP_RRI_15a, SP_RRI_15b, TT_RRI_48, NP_RRI7, NP_RRI23) | Expand the green school program to include additional institutions |
| | Modify, repair, and/or maintain existing stormwater management facilities to improve water quality performance[4] | Develop a green school program that includes reforestation, stormwater retrofits and pollution prevention (300 hrs) | Implement additional high priority stormwater retrofits (TT_RRI_41a, TT_RRI_41b, TT_RRI_74, SP_RRI_102b, SP_RRI_11, NP_RRI34a-b, NP_ RRI 8, NP_RRI10a) |
| | Engage the public through implementation of highly visible, low cost demonstration projects (SP_RRI_8b, SP_RRI_24, NP_RRI1) | Implement stormwater management into existing municipal parking lots during redevelopment (code changes: 200 hrs) | Continue to identify retrofit opportunities at schools, neighborhoods, commercial areas, and outfalls that do not have existing BMPs |
| | Engage neighborhood residents in buffer planting project (TT_IB36_1) | Further assess opportunities in neighborhoods with little or no existing stormwater management (72 hrs) | |
| Strategy 6 Costs | $27,400 | $101,960 | $$$ |
| 7. Implement priority stream improvement projects | Conduct quarterly stream clean-ups (4 events/yr) | Implement additional high-priority stream projects, such as buffer restoration (SP_IB2101, TT_IB36_1, NPIB_105_1). | Incorporate new stream, data into GIS layers and use the data during development plan reviews |
| | Continue use of bag filters on outfalls and consider expansion of program ($20,000/net@5 nets + $5,000 maintenance costs)[5] | Update watershed mapping to account for and differentiate between perennial and intermittent streams. (40 hrs) | Continue to implement additional high-priority stream projects (SP_IB2601; TT_IB5_1; SP_IB_301; NPIB105_2; NPIB104_1). |

**Table 5.2. Implementation Actions and Costs***

| Strategy | Short-Term Action (year 1) | Mid-Term Action (year 2-4)[1] | Long-Term Action (year 5+)[2] |
|---|---|---|---|
| | Continue implementation of illicit discharge outfall screening program ($25,000/year)[6] | Determine potential for Coast Guard auxiliary to assist with trash clean-ups or citizen monitoring efforts in the lower watershed that can only be accessed by boat. (40 hrs) | Implement large demonstration project at SP_SC301 |
| | Obtain grant funding to conduct feasibility study of large-scale water quality improvement project at SP_SC_301 (25 hrs) | Hold regular living shoreline and conservation landscape workshops. (4 events at 32 hrs/3yrs) | |
| | Educate the citizenry regarding invasive species like Japanese knotweed and their control (4 events at 15 hrs each=$1,800) | Implement 1-2 fish barrier projects (TT_SC26_1) | |
| | Control invasive species like Japanese knotweed, esp. in the headwaters (SP_IB1701) | Implement feasibility study at SP_SC_301 ($35,000) | |
| | Conduct outreach to landowners on the river for living shoreline projects (4 events at 32 hrs each) | | |
| Strategy 7 Costs | $149,315 | $74,420 | $$ |
| 8. Investigate strategies for pond management | Provide educational workshops to lakeside homeowners regarding neighborhood source control practices, septic system maintenance (strategy 9) and benefits of shoreline buffers. (4 events at 32 hrs each) | Comprehensive assessment of lakes in the watershed for future action based on pollution, aquatic weeds, flooding and other concerns (1200 hrs) | Implement actions identified in lake restoration assessments. (unknown cost) |
| | Foster opportunities for residents to interact with lake systems where pollution problems are less of a concern. (4 events at 32 hrs each) | | |
| Strategy 8 Costs | $14,080 | $66,000 | $$$$ |

**Table 5.2. Implementation Actions and Costs***

| Strategy | Short-Term Action (year 1) | Mid-Term Action (year 2-4)[1] | Long-Term Action (year 5+)[2] |
|---|---|---|---|
| 9. Minimize the creation of impervious surfaces during the development review process. | Review the City and County development codes using the Codes and Ordinances Worksheet (COW) (60 hrs) | Implemented needed code revisions as determined by the COW (400 hrs) | Where possible, remove excess or unused impervious cover (SP_RRI_22; SP_RRI_100a; TT_RRI_48; TT_RRI_54b). |
| Strategy 9 Costs | $3,300 | $22,000 | $$ |
| 10. Educate homeowners regarding advanced nutrient removal septic systems and connect failing septic systems to the sewer system as per the County's Water and Sewerage Plan (2010). | Provide educational workshops on septic system maintenance (strategy 7) (4 events at 32 hrs each) | Provide educational workshops on septic system maintenance (strategy 7) (14 events at 32 hrs each) | Extend sanitary infrastructure to high priority lakes with adjacent septic systems. |
| Strategy 10 Costs | $7,040 | $24,640 | $$$$ |
| 11. Track and monitor the implementation progress | Determine capacity limitations of local partners identified in Table 5.3 for implementation and identify ways to build capacity in needed areas (e.g. specific training) (40 hrs) | Revisit watershed plan and assess status (40 hrs) | Revise this plan as needed to reflect changes in watershed conditions and new priorities. |
| | Expand a Creekwatcher monitoring program by adding Total suspended solids as parameter (450 samples @ $15/sample = $6,750); conduct detailed synoptic survey of Tony Tank, South Prong, and North Prong ($2500); establish new station in Monie Bay and use as a reference site (40 hrs) | Provide continuing education regarding project maintenance to homeowners, HOAs, schools, municipalities, etc. (4 trainings at 32 hrs each/3 yrs) | |
| | Develop project tracking database in GIS and spreadsheets (40 hrs) | | |
| Strategy 11 Costs | $15,850 | $23,320 | $ |
| **Sub Totals** | **$285,905** | **$1,967,424** | **$$$$** |
| **Grand Total (Short & Mid Term Only)** | **$2,253,329** | | |

**Table 5.2. Implementation Actions and Costs***

| Strategy | Short-Term Action (year 1) | Mid-Term Action (year 2-4)[1] | Long-Term Action (year 5+)[2] |
|---|---|---|---|
| *Note: These cost estimates include staff time, materials, supplies, and construction costs where applicable. A $55 hourly rate was assumed in all calculations. Best professional judgment was used for staff time estimates, projects costs are from Appendix H. Other cost assumptions are documented with footnotes. | | | |
| [1]Costs are calculated for three years within this category where noted, otherwise for one year. A range of 50-150% of estimated costs is provided to account for uncertainty. | | | |
| [2]Costs are calculated for 10 years within this category where noted, otherwise for one year. Since these costs are so unpredictable for the long-term, and likely to change based on inflation and other unknown factors, best professional judgment was used to assign a relative value as such: "$"=$1,000-$10,000; "$$"=$10,000-$100,000; "$$$"=$100,000-$500,000; and "$$$$"=>$500,000. | | | |
| [3]Protection costs based on $2,200/acre, 3% administrative fee to sponsor the project and 1.5% compliance fee. | | | |
| [4]Funding a stormwater post-construction program depends on many factors. See "Managing Stormwater in Your Community: A Guide for Building an Effective Post-Construction Program" (Hirschman et al., 2008) for more information and guidance on developing a budget. | | | |
| [5]Costs from CWP Gross Solids project in Talbot County. | | | |
| [6] Brown el al (2004). | | | |

**Table 5. 3. Wicomico Watershed Restoration Implementation Parties**

| | City / County Plan Dept. | County Public Works | City Public Works | County Schools | SU green groups | HOAs | Churches / Civic Assns | Business | Master Gardeners | WET | CBF | Creek watchers | LSLT | Exten-sion | DNR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Overall Organizational Assessment | | | | | | | | | | | | | | | |
| Financing | x | Through utility / grants | x | | | | | small amounts | | x | | | x | x | funder |
| Design | | x | x | | | | | x | small scale | | | | small scale | x | |
| Construction | | x | x | | | | | x | | | | | | | funder |
| Maintenance | | Depends | x | x | | x | x | | | | | | | Educa-tion regard-ing mainten-ance | |
| Monitoring | | x | x | | | | | | | x | | x | | | |
| Education & Outreach | | x | x | x | x | x | x | | | x | x | x | x | x | |
| Technical Capacity Assessment | | | | | | | | | | | | | | | |
| Contract management | | x | x | | | | | | | if needed | | | | may help with | |
| Grant management | | x | x | | | | | | | if needed | | | x | may help with | |
| BMP design | | x | x | | | | | | | | | | limited | | x |
| BMP construction | | x | x | | | | | | | | | | | | funder |
| Tree planting & /or reforestation | Assess/ plan, not actual planting | | x | x | x | | x | | | x | | | x | | |
| Land conservation | x | | | | | | | | | | | | x | | |
| GIS | x | | x | | x | | | | | | | | x | | |
| Volunteer recruitment | | | | | | x | | | | x | x | | x | | x |

**Table 5. 3. Wicomico Watershed Restoration Implementation Parties**

| | City / County Plan Dept. | County Public Works | City Public Works | County Schools | SU green groups | H O As | Churches / Civic Assns | Business | Master Gardeners | WET | C B F | Creek watchers | LSLT | Exten-sion | DNR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Development of educational materials (paper, social media other) | | | | | x | | | | | x | x | | | x | x |
| Provide volunteers | | | | x | x | x | x | x | | x | | x | | | |
| Geographic Assessment | | | | | | | | | | | | | | | |
| Identify any geographic limitations | | Public lands | Within City limits | Schools | | | | Sites for projects | | | | | | | |
| Other Notes | | | | | | | | | | | | | | | |
| | | Interested in projects that treat large drainage areas | | | | | | | | | | | | | |

*5.3 Monitoring Plan*

The City, County, Wicomico Environmental Trust, and other watershed partners have a vested interest in measuring whether the projects they implement are successful. Success can be measured in a number of ways including direct improvements in watershed indicators (e.g. reduced pollutant loading or improved aquatic insect communities) or indirectly (e.g. number of rain gardens installed, number of volunteers, acres preserved).

The monitoring plan includes the assessment of individual watershed projects and the monitoring of stream indicators at sentinel monitoring stations in the Creekwatcher water quality monitoring program. Guidance on developing monitoring studies is provided in Law et al. (2008). Information can be input to a tracking system and then used to revise or improve the watershed plan over a five to ten year cycle. Each part of the monitoring plan is described below:

- *Project monitoring* at a small scale (reach or smaller) to illustrate benefits of individual restoration efforts. As stormwater retrofits, neighborhood and business pollution prevention and education strategies are implemented monitoring should be conducted to show effectiveness.

- *Sentinel station monitoring* to track long-term health and water quality trends. Sentinel monitoring stations are fixed, long-term monitoring stations which are established to measure trends in key indicators over many years. Sentinel monitoring is perhaps the best way to determine if conditions are changing in a subwatershed or watershed. The Creekwatcher program is an example of a sentinel monitoring program. Expansion of the Creekwatcher program to assess progress towards meeting goals identified in this Plan, may include: 1) adding total suspended solids to the list of parameters analyzed; 2) adding a Creekwatcher station in Monie Bay as reference site and because this is only subwatershed in the Wicomico without a representative station.

- *Repeat synoptic survey for the South Prong and North Prong and add Tony Tank.* Maryland Department of the Environment conducted synoptic sampling of the South prong and North Prong subwatersheds in May, 2012. The data, however, seemed incomplete but it is recognized that this would be a useful approach to identifying nutrient hotspots in the watershed. The survey should be repeated and, once nutrient hotspot reaches are identified, actions and projects can be targeted for these areas.

- *Source Tracking* to better identify watershed pollutant loads. To date, no detailed sourcing studies have been completed in the watershed, so it is difficult to quantify load reductions that should be targeted. Project partners should conduct research to better identify sources of watershed impairment and target future watershed actions to address these sources.

## *5.4 Project Tracking*

Managing the delivery of a large group of restoration projects within a subwatershed can be a complex task. Creating a master project spreadsheet linked to a GIS system can help track the status of individual projects through final design, permitting, construction, inspection, maintenance and any performance monitoring. For non-structural efforts, tracking systems will include measures such as number of stream clean-ups, residents educated, green schools and businesses created, acres of natural resources preserved, or number of dedicated volunteers. By tracking the delivery of watershed projects, implementation progress can be assessed over time, which in turn, helps explain future changes in stream quality. Project tracking can also improve the delivery of future projects, and creates reports that can document implementation progress for key funders and stakeholders.

The watershed coordinator will manage implementation tracking. This person will setup project information in spreadsheet/GIS format, and report on the status of implementation quarterly to the Core Team. The tracking system will account for all watershed practices undertaken in the subwatershed plan regardless of their type or size, and track the progress of outlined milestones.

## *5.5 Long Term Goals*

Long-term goals have been set in the implementation strategy to mark progress to ensure the implementation of the *Plan* adheres to a schedule to meet the defined outcomes.

- Meet interim milestones from Table 5.2 for each strategy
- Reduce baseflow concentrations of nitrogen, phosphorus and bacteria at Creekwatcher monitoring stations to meet local and Chesapeake Bay TMDL reductions. Additional information is needed to better quantify bacteria loading and to develop implementation plans to address bacteria impairments.
- Track improvements in the stream water quality using the existing Creekwatcher monitoring sites. Evaluate at five years any improvements in trends that may have occurred due to implementation efforts.

After 5 years time, this *Plan* should be updated to include recent watershed developments and monitoring results.

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